SOLID STATE

PROGRAMMABLE

OSCILLATOR

MODEL 4030R AND MODEL 4031R

SERIAL NO._____

OPERATING AND MAINTENANCE MANUAL

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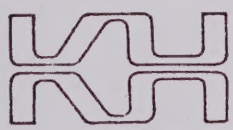

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MODEL 4030R AND 4031R

The following modifications and corrections are not reflected in the Instruction Manual and may be added at the discretion of the customer.

On page 31, line 11, 1st paragraph: C.O.#2421

Should read: "tion is 0.03%,"

On units with a three frequency multiplier, the following changes should be noted: C.O.#2446

Page 30, Section 5.5, second line. Pin letters should be: c,B,K and N.

Page 30, Section 5.7, at 20 Hz pin letters should be: c,B,K and N.

Page 31, Section 5.12, pin letters should be: c,B,K,L,P and R for 63 Hz. For 123 Hz pin letters should be: c,C K,P and R

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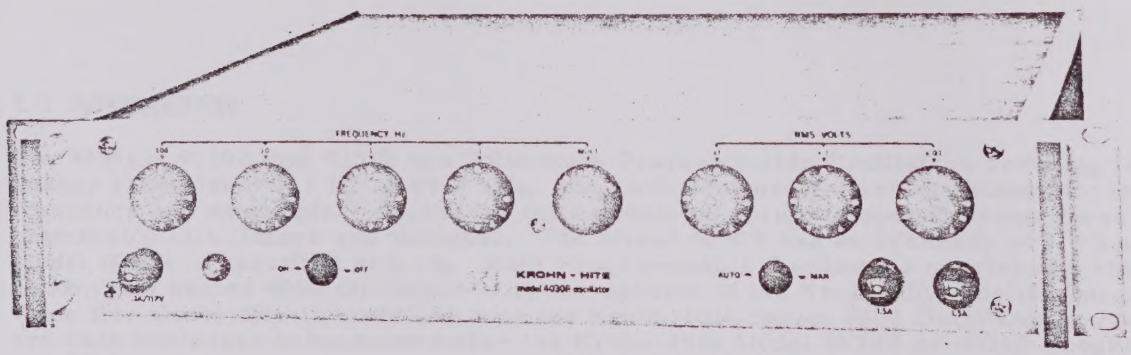


Model 4030R Progammable Oscillator

SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The Models 4030R and 4031R are Solid State Programmable Oscillators covering the frequency range from 0.1 Hz to 99.9 kHz, and were designed for remote automatic control of frequency and amplitude. Except for the calibration accuracy specification, these Programmable Oscillators are identical. The Model 4030R has an accuracy of 0.5% and the Model 4031R is specified at 0.1%. Both Programmable Oscillators consist of a standard Krohn-Hite Series 4000 Oscillator with the addition of the Krohn-Hite Digital Controller. When this Controller is combined with the Krohn-Hite Series 4000 Oscillator in one standard rack enclosure it becomes either the Krohn-Hite Model 4030R or 4031R Programmable Oscillator.

1.2 DESCRIPTION

This Programmable Oscillator is relay operated and digitally programmed to provide automatic programmed frequency and amplitude, by means of several commonly available methods such as punched or magnetic tape, punched cards or computer output. In the standard Programmable Oscillator a maximum of three digits of frequency are provided. Each digit of frequency is formed from the standard binary coded decimal 1-2-4-8 system and consists basically of four relays and associated circuitry, mounted on a printed circuit Frequency Plug-in Module, coded to the numerals 0 (reset), 1, 2, 4 and 8, which are operated in the combinations required to generate the integers one through nine. Two additional Multiplier Plug-in Modules with appropriate relays, circuitry and frequency determining capacitors are used to control frequency in decade bands.

The relays which select the frequency are driven by internal solid-state amplifiers so that actuation of a relay is accomplished either mechanically or electrically by contact closure of the appropriate relay line for a period of not less than 5 milliseconds. Silicon-controlled-rectifiers in these amplifiers provide the holding action which maintains these relays energized after the external programmed information is removed. The maximum voltage appearing on the relay control line under open-circuit conditions is approximately 15 volts, negative with respect to common or program ground, and the operating current when the circuit is closed will not exceed 4 milliamperes.

This Programmable Oscillator has a unique automatic reset circuit which eliminates the need for an additional reset operation. All relays in one digit, not required in the new program, are automatically reset immediately upon application of the "operate" signal (contact closure of the control line). An automatic timing sequence that is actuated by the new program resets all relays not required by the new program. If programming is accomplished by continuous contact closure, the contacts must be opened for a period of at least 3 milliseconds to allow for recovery of this automatic reset before new programming information is applied.

1.3 TECHNICAL SUMMARY

FREQUENCY SELECTION

The standard Programmable Oscillator provides three significant frequency digits. An additional digit can be supplied as an option for increased frequency resolution. The binary coded decimal 1-2-4-8 system is standard. In this system, each digit has associated with it four relays coded to the numerals 0 (reset), 1, 2, 4 and 8, which are closed in the combinations needed to generate the integers 1 through 9. Other systems, such as the 1-2-2-4 code or the straight binary representation of numbers can be accommodated on request. Additional relays shift the frequency range in bands. The frequency ranges for the standard Programmable Oscillator are shown in the following table together with the smallest frequency increment (Δ Hz) available in each band.

BAND	FREQUENCY (Hz)	Δ Hz
1	0.1 - 99.9	0.1
2	100 - 999	1
3	1,000 - 9,990	10
4	10,000 - 99,900	100

1 - 999
10 - 9990
100 - 99900

FREQUENCY CALIBRATION ACCURACY

Model 4030R: Within ±0.5% from 10 Hz to 9.99 kHz, rising to ±1% at 50 kHz, ±2% at 99.9 kHz and to ±5% at 0.1 Hz.

Model 4031R: Within ±0.1% from 10 Hz to 9.99 kHz, rising to 0.25% at 50 kHz, ±0.5% at 99.9 kHz, and to 1% at 0.1 Hz.

FREQUENCY STABILITY

Vs. Time

Model 4030R: Within ±0.02% from 10 Hz to 50 kHz, and ±0.1% from 0.1 Hz to 99.9 kHz, in any period of one hour or less. Within ±0.1% from 10 Hz to 50 kHz, and ±0.5% from 0.1 Hz to 99.9 kHz, in any period of ten hours or less.

Model 4031R: Within ±0.005% from 10 Hz to 9.99 kHz, rising to ±0.05% at 0.1 Hz and 99.9 kHz in any period of one hour or less. Within ±0.01% from 10 Hz to 9.99 kHz, rising to ±0.1% at 0.1 Hz and 99.9 kHz in any period of ten hours or less.

Vs. Temperature

Model 4030R: Within ±0.02% per degree C from 10 Hz to 50 kHz, and ±0.1% per degree C from 0.1 Hz to 99.9 kHz.

Model 4031R: Within ±0.005% per degree C from 10 Hz to 9.99 kHz, rising to ±0.05% per degree C at 0.1 Hz and 99.9 kHz.

Vs. Line

Within ±0.005% for a 10% change in line voltage.

Vs. Load

Within ±0.005% from 1 Hz to 9.99 kHz, and ±0.05% from 0.1 Hz to 99.9 kHz, no load to full load.

PROGRAM CONTROL

The relays which select the frequency are driven by internal solid-state amplifiers, so that actuation of a relay is accomplished by contact closure of the appropriate relay line for a period of not less than 5 milliseconds. Contact closure can be performed mechanically or electrically using semiconductor switching devices. The maximum voltage appearing on the relay control line under open-circuit conditions is approximately 15 volts, negative with respect to common or program ground, and the operating current when the circuit is closed is approximately four milliamperes. Note that no reset operation is required. All relays not required in the new program in one digit are automatically reset immediately upon application of the "operate" signal (contact closure of the control line). An automatic timing sequence resets all relays not required in the new program at the same time the new program is set in. If programming is accomplished by continuous contact closure, the contacts must be opened for a period of at least three milliseconds to allow for recovery of the reset before new programming information is applied. Since the Digital Controller has its own independent Power Supply, the program circuitry is isolated.

PROGRAM TIME

Relay operation itself is completed within approximately 5 milliseconds after the actuating signal.

MAIN AND QUADRATURE SINE WAVE OUTPUTS

Voltage

10 volts rms maximum open-circuit, 5 volts rms across a 200 ohm load.

Current

30 milliamperes maximum.

Power

125 milliwatts maximum from each output simultaneously into 200-ohm loads.

Internal Impedance

Constant 200 and 600 ohms, ±2%.

AMPLITUDE CONTROL

The Main sine wave output control in the standard Programmable Oscillator consists of an eleven position switch providing ten 1-volt increments from zero to 9 inclusive. In an additional position (0-0.1) a concentric infinite-resolution vernier provides continuous control from near zero (approximately 1 millivolt) to a nominal 100 millivolts. In the next ten positions this vernier covers a nominal 1-volt range. The Quadrature sine wave output is fixed at 10 volts rms, ±2%.

AMPLITUDE CALIBRATION ACCURACY

At no load with vernier amplitude control at maximum ccw position, within ±2% of indicated attenuator setting ±2 millivolts for frequencies from 1 Hz to 20 kHz, rising to ±2% ±20 millivolts at 99.9 kHz.

HARMONIC DISTORTION

Main Output

Less than 0.01% from 1 Hz to 20 kHz, rising to 0.05% at 50 kHz, and 0.1% at 0.1 Hz and 99.9 kHz.

Quadrature Output

Approximately twice the Main Output values.

FREQUENCY RESPONSE (NO LOAD OR RESISTIVE LOAD)

Main Output

Within ±0.01 db from 20 Hz to 20 kHz, ±0.05 db from 1 Hz to 99.9 kHz, ±0.5 db at 0.1 Hz.

Quadrature Output

Within ±0.1 db from 20 Hz to 20 kHz, ±0.5 db from 0.1 Hz to 99.9 kHz.

AMPLITUDE STABILITY

Vs. Time

Within ±0.01% from 20 Hz to 20 kHz, and ±0.05% from 1 Hz to 99.9 kHz, in any period of one hour of less. Within ±0.02% from 20 Hz to 20 kHz, and ±0.1% from 1 Hz to 99.9 kHz, in any period of 10 hours or less. Within ±0.1% from 20 Hz to 20 kHz, and ±0.5% from 1 Hz to 99.9 kHz, in any period of 100 hours or less. Quadrature amplitude is less stable by a factor of approximately 2.

Vs. Line

Within ±0.001% from 20 Hz to 20 kHz, and ±0.01% from 1 Hz to 99.9 kHz, for a 10% change in line voltage within operating limits. Quadrature amplitude change is approximately twice these values.

Vs. Temperature

Within ±0.01% per degree C from 20 Hz to 20 kHz, and ±0.1% per degree C from 1 Hz to 99.9 kHz. Quadrature amplitude change is approximately twice these values.

TUNING TRANSIENTS

Typical deviation ±1 db, recovering within 20 milliseconds or a few cycles whichever is greater.

HUM AND NOISE

Less than 0.01% of output at any setting of output attenuators. Cycle-to-cycle amplitude variation less than 0.01%.

AMPLITUDE MODULATION (LINE FREQUENCY BEAT)

Less than 0.01% near line frequency or its harmonics.

EXTERNAL SYNCHRONIZATION

A 0.25 volt peak-to-peak signal will lock Programmable Oscillator over a range of approximately ±0.5% and distortion will increase to approximately 0.05%. Locking range and distortion increase linearly with input amplitude. Relative phase shift is controlled by Oscillator tuning. See section 2.7 for additional information.

OUTPUT CIRCUIT

Direct-coupled resistive network.

DC COMPONENT

Nominal zero volts. At maximum output, drift is less than 1 millivolt per degree C, less than 1 millivolt for a 10% line voltage change, and within ±5 millivolts in any period of 10 hours or less. Drift reduced in proportion to output signal.

FLOATING (UNGROUNDED) OPERATION

A grounding switch is provided to disconnect the signal ground from the chassis ground. In this mode, performance is slightly reduced above 10 kHz. Balanced output operation is possible in the "floating" mode.

QUADRATURE PHASE ACCURACY

Model 4030R: ±0.5 degree. Higher at ends of range.

Model 4031R: ±0.25 degree. Higher at ends of range.

OUTPUT VOLTAGE CONTROL

The amplitude control in the standard Programmable Oscillator is manual. Up to four digits of programmed amplitude control are available, as options, depending on the resolution desired. The digits represent voltage increments as follows:

First	- volts, zero to nine
Second	- tenths of volts, zero to nine
Third	- hundredths of volts, zero to nine
Fourth	- millivolts, zero to nine

Each digit is formed from the standard binary coded decimal 1-2-4-8 system, similar to the frequency digit selection. Other codes can be accommodated on special order. With four digits of amplitude control, the minimum resolution is one millivolt. Amplitude calibration accuracy at no load is within ±0.25% of program setting ± one millivolt for frequencies from 20 Hz to 10 kHz, and within ±0.7% ±10 millivolts from 0.1 Hz to 99.9 kHz, after periodic calibration.

SQUARE WAVE OUTPUT (Optional)

Voltage

Continuously adjustable from nominal zero to 5 volts peak-to-peak open-circuit, 2.5 volts peak-to-peak across 50 ohms.

Current

100 milliamperes peak-to-peak maximum at very low load impedance, without waveform deterioration.

Waveform Details

Rise and fall time less than 20 nanoseconds; symmetrical within 1%; flat top with no droop and less than 5% overshoot at maximum amplitude.

PULSE OUTPUT (Optional)

Voltage

Continuously adjustable from nominal zero to 5 volts peak open-circuit, or 2.5 volts peak across 50 ohms.

Current

100 milliamperes maximum peak at very low load impedance, without waveform deterioration.

Waveform Details

Choice of positive or negative polarity; rise and fall time less than 20 nanoseconds; flat top with no droop and less than 5% overshoot at maximum amplitude: width continuously variable in three decade ranges from 0.1 μsec to 100 μsec.

AMBIENT TEMPERATURE AND DUTY CYCLE

Continuous operation from zero to 50 degrees C.

PROGRAM INPUT CONNECTOR

AMP type 200276-2 rear of chassis. Mating connector supplied.

POWER REQUIREMENTS

105-125 or 210-250 volts, single phase, 50-400 Hz, 50-70 watts (depending on options).

DIMENSIONS (RACK-MOUNTING ONLY)

19" wide, 3 1/2" high, 16" deep.

WEIGHTS

Approximately 20 lbs. net, 25 lbs. shipping (depending on options).

SECTION 2

OPERATION

2.1 INTRODUCTION

On receipt of the Programmable Oscillator, carefully unpack and examine it for damage that may have occurred in transit. If signs of damage are observed, file a claim with the transporting agency immediately, and notify Krohn-Hite Corporation. Do not attempt to use this instrument if damage is suspected.

2.2 OPERATION

To operate the Programmable Oscillator, proceed as follows:

a. Make appropriate power connections. See Section 2.9.

b. Make appropriate connections to the OUTPUT connectors located on the rear of the chassis.

c. Make appropriate connections to the PROGRAM INPUT connector, located on the rear of chassis, as described in Section 2.3.

d. For normal operation the FLOATING CHASSIS ground switch, located on the rear of the chassis, should be in the CHASSIS position. If the Programmable Oscillator is used in a system where ground loops make ungrounded or floating operation essential, this switch should be in the FLOATING position.

e. When the Programmable Oscillator contains optional front panel controls for manual selection of frequency, a front panel AUTO/MANUAL toggle switch selects the desired mode of operation. In the AUTO position the front panel FREQUENCY decade switches are inactivated and the Programmable Oscillator requires remote programming for control of frequency. In the MANUAL position the Programmable Oscillator cannot be programmed, and frequency can only be varied manually by the appropriate front panel decade switches.

When switching from AUTOMATIC to MANUAL position the resultant frequency will correspond to the setting of these manual decade switches, and not be affected by the programmed input information. Alternatively when switching back to the AUTOMATIC position the Programmable Oscillator will revert to a frequency determined by the programmed input information.

If programmed amplitude is incorporated in the Programmable Oscillator and optional front panel controls for manual selection of amplitude is also included, these amplitude controls will function in a manner similar to the frequency controls.

2.3 FREQUENCY SELECTION

The standard Programmable Oscillator provides three significant frequency digits using the 1-2-4-8 binary coded decimal system. Each digit has associated with it four relays coded to the numerals 0 (reset), 1, 2, 4 and 8, which are closed in the combination needed

to generate the integers 1 through 9. These relays are driven by internal solid-state amplifiers so that actuation of a relay is accomplished by electrical or mechanical contact closure of the appropriate relay control line for not less than 5 milliseconds duration. The maximum voltage appearing on this relay line prior to contact closure is approximately 15 volts negative with respect to common or program ground and the control line operating current during closure will not exceed 4 milliamperes.

Supposing it is desired to operate the Programmable Oscillator at a frequency of 2.35 kHz. To accomplish this, it is necessary to refer to the lower part of the Main Assembly Schematic Diagram, Figure 14, which shows the internal wiring connections between the PROGRAM INPUT connector, located on the rear of the chassis, and the Frequency and Frequency Multiplier plug-in Modules in the Digital Controller. Each pin of this connector is tied to a control line which operates a relay in these Modules that varies frequency and frequency band multiplier.

To obtain a frequency of 2.35 kHz, it is necessary to short pin D of the PROGRAM INPUT connector to pin A which is common or program ground. This programs the first digit of 200 in the X100 Frequency Module. The second digit of 30 is obtained by programming the digits 20 and 10 simultaneously in the X10 Frequency Module. This is accomplished by shorting pins J and K simultaneously to pin A. Shorting pins P and S to pin A simultaneously generates the third digit of 5 in the X1 Frequency Module. At this point, if all of the above connections have been made three digits of frequency, 235, have been programmed. It is only necessary to program in the X10 frequency band multiplier to obtain a frequency of 235 X10 or 2.35 kHz. This is accomplished by shorting pin b to pin A.

If a frequency of 23.5 kHz rather than 2.35 kHz was required it would be necessary only to short pin a to pin A instead of pin b to pin A to obtain a band multiplier of X100.

Each digit of frequency has its own control line for reset operation. This is to provide for applications where it is required to program one digit of frequency at a time.

The reset positions can be tied together to provide a common reset operation. In this condition the reset switch should have a current capacity to accommodate the total reset current of 2 milliamperes per digit.

2.4 RESET OPERATION

An automatic reset circuit is incorporated in this Programmable Oscillator, which eliminates the need of programming an additional reset operation. All relays in one digit not actuated by the control lines are automatically reset immediately after contact closure of the control lines.

For some applications such as sequential programming where it is necessary to program one control line at a time it may be necessary to remove the automatic reset. This can be accomplished easily by simply removing one jumper on each Frequency plug-in Module as shown in the Schematic Diagram, Figure 17. Without automatic reset it will be necessary to reset before new programming information is applied.

2.5 AMPLITUDE SELECTION

Automatic programming of amplitude if incorporated in the Programmable Oscillator can be accomplished in a manner similar to that used for frequency programming. For example if a voltage of 3.947 volts rms is required, as shown in Figure 14, it is necessary to short pin j and k simultaneously to pin A to obtain a units digit of 3, pin r and u simultaneously to pin A for 0.9, pin y to pin A for 0.04, and pin BB, CC and DD simultaneously to pin A for 0.007. The reset positions for each digit of amplitude can be tied together to provide a common reset operation similar to the common frequency reset operation.

2.6 SQUARE WAVE AND PULSE OPERATION

A Square Wave and Pulse Output, at the Programmable Oscillator operating frequency, is available as a standard option. A choice of either a Square Wave or Pulse is available by placing the front panel FUNCTION/PULSE WIDTH μs switch in the appropriate position. In its center (12 o' clock) position, the switch selects the Square Wave alternative. The three positions to the left of center provide a negative pulse, while the three to the right provide a positive pulse, whose width can be varied by means of the concentric vernier over the three ranges of 0.1 to 1 μsec, 1 to 10 μsec, and 10 to 100 μsec.

The P-P VOLTS front panel control is calibrated in peak-to-peak volts and adjusts the amplitude of the Square Wave and Pulse to a maximum of +2.5 volts and -2.5 volts with reference to signal ground. As this control is varied, the positive and negative excursions of the wave form increase or decrease simultaneously, by equal amounts.

2.7 EXTERNAL SYNCHRONIZATION

An EXTERNAL SYNC connector on the rear of the chassis is provided to synchronize the frequency of the Programmable Oscillator to an external signal. Connect the external signal to the EXTERNAL SYNC input and tune the Programmable Oscillator to a frequency approximately at the mid-point of the range of variation expected of the external signal. With an external sine or square wave input of 1/4 volt peak-to-peak, the Programmable Oscillator output will be locked in frequency to the external synchronizing signal over a range of approximately ±1/2% of the Programmable Oscillator frequency setting, and distortion will be approximately 0.05%. Locking range and distortion increase linearly with input amplitude up to a maximum range of approximately ±15%. With an external sine wave input, the distortion is nearly constant within the locking range. However, with a square wave input, the distortion remains low in the center of the range, but is higher at the ends of the range than with a sine wave. With a sine wave clipped by back-to-back diodes, the distortion is lower over most of the range than with a sine or square wave for the same locking range.

2.8 TERMINALS AND CONNECTORS

BNC coaxial connectors are provided on the rear of the chassis for both the MAIN and QUADRATURE outputs. The PROGRAM INPUT connector also on the rear of the chassis is an AMP type 200276-2. A mating connector is also supplied.

2.9 LINE VOLTAGE AND FUSES

The Programmable Oscillator, unless otherwise specified, is connected for operation from an a-c power source of 105-125 volts, 50 to 400 Hz, and uses two 0.4 ampere slow-blow line fuses, one for the Series 4000 Oscillator that is mounted on the front panel and the other for the Digital Controller that is mounted on the rear of the chassis. The Programmable Oscillator may be modified to operate from a 210-250 volt line by removing the two jumpers connecting terminals 1 to 3, and 2 to 4 of both power transformers, and adding a jumper between 2 and 3 of both power transformers. Slow-blow fuses of 0.2 ampere rating should be used for 210-250 volt operation.

There are two additional 1.5 ampere fast-blow fuses mounted on the front panel. One is used to protect the -13.5 vdc Digital Controller power supply that is used for frequency programming and the other is either a spare fuse holder or else is used to protect the -12 vdc Digital Controller power supply used only for optional amplitude programming.

SECTION 3

CIRCUIT DESCRIPTION

3.1 INTRODUCTION

A regenerative circuit will oscillate if two conditions are fulfilled. The net phase shift around the entire regenerative loop must be zero degrees and the voltage gain around the loop must be exactly unity at the oscillating frequency. In the Programmable Oscillator, two amplifiers G1 and G2, in conjunction with their associated frequency determining networks R_1C_1 and $R_2R_3C_2$, produce a net phase shift of zero degrees at the oscillating frequency. Refer to Figure 1 Simplified Block Diagram. The phase shift introduced by R_1C_1 is 45 degrees leading, and that produced by $R_2R_3C_2$ is 45 degrees lagging, for a net shift of zero degrees around the entire loop. The phase relationship established in this manner leads to two useable output signals E_1 and E_2 which bear a fixed 90 degree relationship to each other at any oscillating frequency.

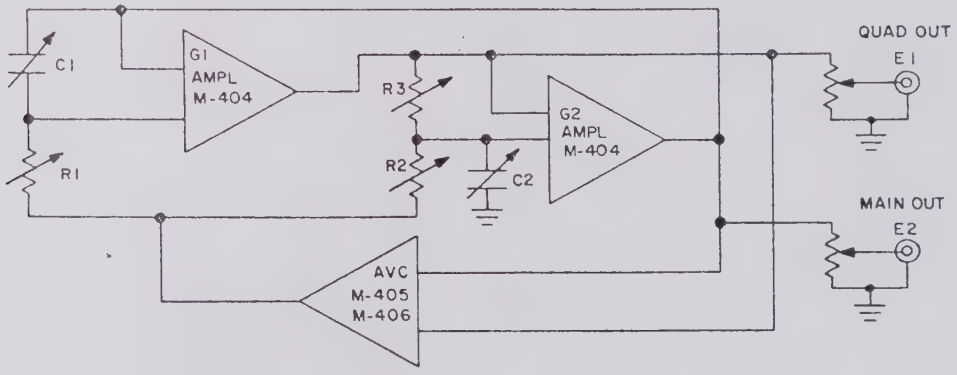


Figure 1. Programmable Oscillator Simplified Block Diagram

A net loop gain of unity is obtained by the AVC (automatic volume control) circuit which samples the output voltage E_2, comparing it to a stable dc reference voltage and generates a control signal. This control signal maintains the overall loop gain at exactly unity by decreasing or increasing the gain when the output voltage, E_2, changes for any reason. Since the output voltage E_2 is the one which is sampled and controlled, it is called the Main sine wave output, where E_1 is called the Quadrature (cosine) sine wave output.

3.2 FREQUENCY DETERMINING CIRCUITS

The frequency determining network for this Programmable Oscillator consists of decade capacitors, C_1 and C_2, of the same value to establish each decade or band of frequency and resistors R_1, R_2 and R_3 which establish the frequency within decades. All of these frequency determining network components are mounted on the Frequency and Frequency Multiplier plug-in Modules that are located in the Digital Controller. Relays on these

modules, which can be programmed or operated remotely, are used to select the required components for a desired frequency of oscillation.

3.3 FREQUENCY MODULE

In the standard Programmable Oscillator, a maximum of three digits of frequency are provided. As shown in the Schematic Diagrams of the Frequency Module, Figure 17, each digit of frequency consists basically of four relays and associated circuitry coded to the numerals 0 (reset), 1, 2, 4 and 8, which are operated in the combinations required to generate the integers one through nine. The relays which select the frequency are driven by internal solid-state amplifiers so that actuation of a relay is accomplished by contact closure of the appropriate control or relay line.

Since the circuitry associated with each relay is identical, we shall confine our discussion to one stage which is shown in simplified form in Figure 2.

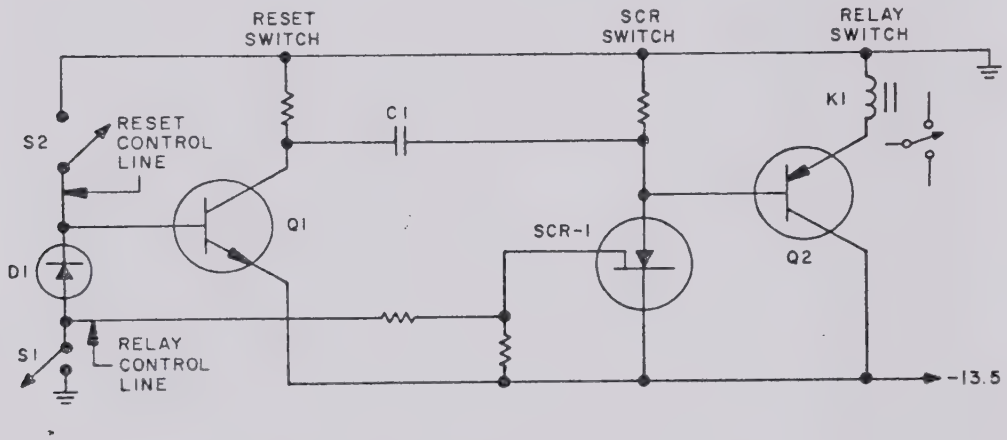


Figure 2. Relay Simplified Schematic Diagram

A silicon-controlled-rectifier SCR-1, which is normally off, is used to energize the relay, K-1, by turning on the relay driver switching transistor Q-2. With the relay control line switch S1 open the SCR is off since its gate is at the same potential as its cathode. Q2 is also non-conducting since its base and emitter are at the same potential. A contact closure of the relay control line via S1 turns on SCR-1 because its gate is driven positive which in turn switches Q2 on and energizes the relay. The SCR provides the holding action since it will continue to conduct after the control line is opened, and will not turn off until the reset circuitry is put into operation.

The reset circuitry consists of the switching transistor Q1, whose collector output is capacitor-coupled to the anodes of the SCR. Normally Q1 is non-conducting until contact closure of the reset control line via S2 is shorted which drives Q1 to saturation. The resulting negative pulse via C1 develops a reverse bias at the anode of the SCR which then shuts off. Diode D1 establishes the path that provides automatic reset operation. It also is used to prevent contact closure of the reset line from triggering the SCR.

To explain automatic reset operation, let us review chronologically the circuit performance after programming any one relay control line such as 4. Referring to the Frequency Module Schematic Figure 17, immediately upon contact closure of the number 4 line, that must be maintained for not less than 5 milliseconds, Q901, the reset switch, is driven to

saturation via diode CR902. This generates a negative pulse at the collector of Q901 which reverse biases all four SCR's to cutoff, via capacitors C901, C903, C905 and C907, within a time not exceeding 500 microseconds. Since the 4 control line remains closed for a minimum of 5 milliseconds, only SCR903 will maintain conduction immediately after the decay of the negative reset pulse. To eliminate automatic reset operation it is necessary only to interrupt, as shown in Figure 17, the path between the 4 control line and the base of the reset switching transistor Q901.

All four relays in the Frequency Module switch the frequency determining resistors whose values are listed in table shown in Figure 17. The standard Programmable Oscillator has three frequency digits and four frequency multipliers of X100, X10, X1 and X0.1. An optional fourth digit is available which requires a X0.01 multiplier.

3.4 FREQUENCY MULTIPLIER MODULE

In the standard Programmable Oscillator there are two Frequency Multiplier plug-in Modules with appropriate relays, circuitry and frequency determining capacitors to control frequency in four decade multiplier bands of X100, X10, X1 and X0.1. When an additional fourth frequency digit is required, a fifth multiplier band of X0.01 is provided. The Schematic Diagram of the X100, X10 and X1 Frequency Multiplier Module is shown in Figure 18. The Schematic Diagram of the X0.1 and X0.01 Frequency Multiplier Module is shown in Figure 19. The X100 band multiplier position is also used as the reset position for the frequency multiplier. The circuitry and operation of the frequency multiplier relays is similar to that of the frequency digit relays.

3.5 AMPLITUDE MODULE

There are up to four Amplitude plug-in Modules available as standard options, with appropriate relays, circuitry and resistive networks to control rms volts output amplitude remotely. The circuitry and operation of these relays, as shown in the Schematic Diagram of the Amplitude Module Figure 20, is also similar in operation to the frequency digit relays.

3.6 AMPLIFIERS

Both the G1 and G2 amplifiers in the Series 4000 Oscillator are identical, using Amplifier Module M404, shown in Figure 11. The amplifier consists of three gain stages and an emitter follower output stage. The differential input stage uses two field effect transistors, Q403A and Q403B, plus three transistors Q401, Q402 and Q409. Input 1, a very high impedance input, is connected to the gate of Q403B, and input 2, a low impedance input, is connected to the gate of Q403A after being added to the output signal in feedback summing resistors R403 and R404. Q409 acts like a high-value load resistor while at the same time passing the required bias current with a relatively low supply voltage. A high effective load resistance at this point approximates a constant-current source and maintains the sum of the input stage drain currents constant. The common-mode signal, appearing at the junction of R412 and R413 at practically full amplitude, is added to a positive dc level and then fed to the input stage drain load resistors through the unity-gain amplifier loop, Q401 and Q402. R412 and R413 are trimmed to set the output dc level to its nominal value, zero volts. The differential output signal of the first stage, developed across R415 and R416, is connected to the bases of Q404 and Q405, the second differential gain stage. Q410 functions in exactly the same manner as Q409 and provides high-common-mode signal rejection in the second stage. A single-ended output signal is taken from R410 and fed to the base of Q406. This is a grounded-emitter stage which is used to drive the output follower. The complementary push-pull emitter follower output stage, Q407 and Q408 is fed directly from the collector of Q406. CR401 and CR402 provide thermal compensation and also establish a bias for proper quiescent current in Q407 and Q408.

3.7 AVC

The AVC circuit consists of two modules, the Main AVC plug-in Module M405, as shown in Figure 12 and the Reference AVC plug-in Module M406, shown in Figure 13. The AVC output is a square wave whose amplitude is dependent on the deviation of the Main sine wave output, E_2, from its correct amplitude, and whose phase with respect to the Quadrature sine wave output, E_1, is zero or 180 degrees, depending on the direction of E_2 deviation. The AVC can best be understood by utilizing the Simplified Block Diagram shown in Figure 3 in conjunction with the Schematics Figure 12 and 13.

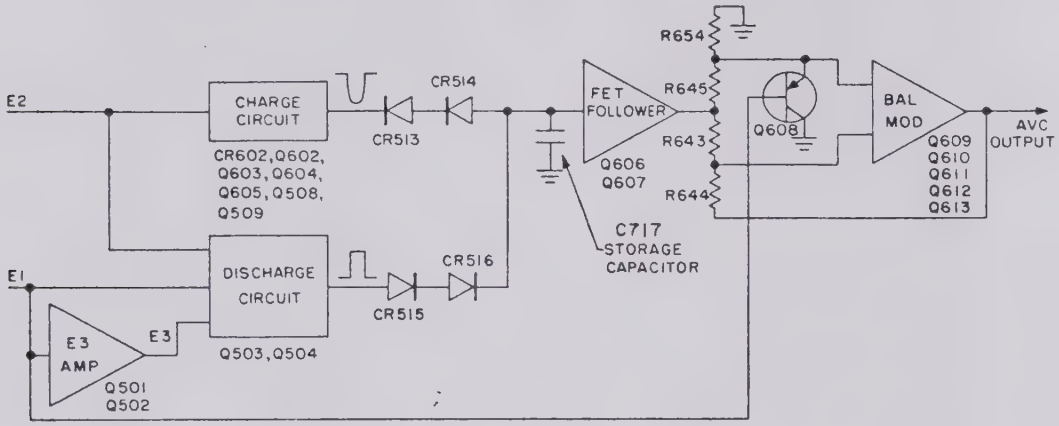


Figure 3. AVC Simplifier Block Diagram

The basic principle of operation of the AVC circuit is that of depositing a charge on a storage capacitor C717 proportional to the Main sine wave amplitude, E_2, and using the resulting dc potential to control the balanced modulator which provides the AVC output signal. The potential across C717 is determined by the relative amplitude of both the Charge pulse and Discharge pulse. The Charge pulse, appearing at the collector of Q509, is negative and its width and amplitude vary with E_2 amplitude. This is accomplished by back biasing diode CR602 and permitting only the extreme negative peak of E_2 to be amplified by Q602. The Discharge pulse, appearing at the collector of Q504, is positive and of constant amplitude and width. It is generated by rectifying E_1, E_2 and E_3 via diodes CR502, 503 and 504. The composite rectified signal drives Q504 to conduction at the negative peak of E_2. If the E_2 level is correct, the net potential of capacitor C717 after both pulses have occurred is zero. If the amplitude of E_2 increases, the amplitude of the Charge Pulse increases and a net negative potential is left on C717, since the amplitude of the Discharge pulse remains constant. Conversely, if the amplitude of E_2 decreases, the potential of C717 becomes positive.

The dc potential of C717 is transferred to the balanced modulator by FET follower Q606 and emitter follower Q607. The modulator Q608 is supplied with the dc error signal from Q607, and Quadrature output signal, E_1. The action of Q608 is such that when the dc error signal is zero, no ac signal whatever is generated at the base of Q609. If the dc level goes positive, Q608 conducts when E_1 goes negative and the dc level at the base of Q609 is pulled back down to ground level during the time E_1 is negative. The phasing is such that the resulting AVC correction signal is a square wave in phase with the E_1 signal. When the dc level goes negative, conduction in Q608 again takes place when E_1 is negative, but in this case the base of Q609 is pulled up to ground level during the time E_1 is negative. The AVC correction signal again is a square wave, but in this case the phasing is such that the square wave is 180 degrees out of phase with E_1.

3.8 TRANSIENT CONDITIONS

The preceding discussion covers the steady-state condition when the output amplitude is normal or very close to normal. When the output amplitude deviates widely from normal, fast recovery circuits restore normal amplitude more rapidly. When the level of E_2 drops below normal, Q605 becomes non-conducting, and the Discharge pulse path to C717 is paralleled by the low impedance path consisting of R537, C510 and CR519.

When the E_2 amplitude is above normal, the Charge pulse path is paralleled by the low impedance path consisting of R534, C511 and CR521. The Charge pulse is normally narrower than the Discharge pulse and CR509 clamps any Charge signal at the junction of R534 and C511. However, then E_2 exceeds its normal level, the Charge pulse becomes wider and two large charge pulses are fed to C717 through C511, lowering the potential of C717 and restoring the correct E_2 amplitude. When the amplitude of E_2 is extremely high, a direct path is provided by diodes CR521 and 522 for the negative half-cycle of E_2 to discharge C730 very rapidly.

3.9 SQUARE WAVE AND PULSE GENERATOR

The optional Square Wave and Pulse generator plug-in Module M402 is triggered by the sine wave output. As shown in the Schematic Diagram Figure 15, the sine wave is first shaped by the input Schmidt trigger circuit consisting of Q207, Q208 and Q209 to produce a square wave suitable for triggering the multivibrator, Q203 and Q204. Q210 and P201 adjust the triggering level of the input Schmidt trigger and thus control the symmetry of the square wave trigger pulses. The multivibrator output, which is in phase with the input trigger signal, is fed to switch circuit Q201 and Q202, and the other output is fed to switches Q205 and Q206. Q214 is a constant-current source which supplies 50 milliamperes to the output P-P Volts potentiometer, developing a level of plus 2.5 volts dc at the output under conditions of no signal, no load, and maximum setting of the output control. Q215 is normally non-conducting. When the Function switch is in the square wave position, Q215 passes 100 milliamperes and sets the output dc level at minus 2.5 volts for no signal, no load, and maximum setting conditions. Switch circuit Q205 and Q206 selects the negative-going multivibrator output which turns Q215 off and produces a square wave at the output which is in phase with the sine wave output. The pulse width Schmidt trigger is disabled and does not operate in the square wave position. In the pulse positions of the Function switch, when the multivibrator is triggered by the positive-going sine wave crossing of the zero axis, current flows into the pulse width capacitors, allowing the potential at the input of the pulse width Schmidt trigger Q211, Q212 and Q213 to rise at a rate determined by the capacitor value and the setting of the Pulse-Width control. When this potential reaches the triggering level of the width trigger, a signal is sent to the multivibrator to reverse its state, thus forming a pulse rather than a square wave. When the Function switch is in the plus pulse position, the operation is the same as for a square wave output except that the duration of the positive excursion is reduced. In the minus pulse position, switch Q201 and Q202 selects the positive-going pulse from the multi-vibrator to turn Q215 on for the duration of the pulse, thus forming a negative-going output pulse.

3.10 SQUARE WAVE

The Square Wave plug-in Module, M403, as shown in the Schematic Diagram Figure 16, is similar to Module M402 but provides only a square wave output. The pulse width Schmidt trigger, the Function and Pulse-Width controls, and the switch circuits are not included. Only the internal symmetry control and the external P-P Volts control remain. The input Schmidt trigger, multivibrator and output circuits function as described above.

3.11 POWER SUPPLY

There are two independent power supplies in the Programmable Oscillator, one for the Series 4000 Oscillator and the other for the Digital Controller. The Series 4000 Oscillator Power Supply Module, M401, as shown in Figure 10 furnishes three regulated voltages of +25, +20, and -20 volts. The +25 volt output is obtained from the first regulating circuit. Z101 supplies the reference voltage, Q101 and Q103 are the regulating amplifiers, and Q701 is the series transistor. Using +25 volts as a reference, the -20 volt output is obtained from the second regulating circuit. Q107, Q108 and Q110 are amplification stages, and Q702 is the series transistor. Current limiting is provided within the amplifier by voltage developed across R125 and amplified by Q109. The +20 volt supply uses the -20 volt regulated output as a voltage reference. Q104 is the regulating amplifier and Q105 is the series transistor. Current limiting for the +25 volt output is provided by voltage developed across R101 and amplified by Q102. In a similar manner, current limiting for the +20 volt output is provided by voltage developed across R119, amplified by Q106, and fed in to the +25 volt regulating amplifier via Q102.

The controller supply as shown in the lower left part of the Main Assembly Schematic Diagram, Figure 14, consists of a -13.5 volt regulated supply that is used to power the Frequency Digits and Frequency Multiplier plug-in Modules, and a -12 volt unregulated supply that is used only for powering the optional Amplitude plug-in Modules. Both supplies consist of bridge rectifiers CR150 and CR151 and filter capacitors C150 and C151. The -13.5 volt regulated supply is a typical series type using transistor Q150 as a zener reference, and amplifiers Q151 and Q152 which drive a series regulator Q153. A divider network, consisting of R154 and R155, determines the magnitude of the nominal -13.5 volt regulated output voltage.

SECTION 4

MAINTENANCE

4.1 INTRODUCTION

If the Programmable Oscillator is not functioning properly and requires service, the following procedure may facilitate locating the source of trouble. The general layout of major components of the Programmable Oscillator is shown in Figure 4. The Model 4030R Programmable Oscillator consists of the standard Krohn-Hite Series 4000 Oscillator with the addition of the Krohn-Hite Digital Controller. The Series 4000 Oscillator is mounted on the left side of the chassis and the Digital Controller on the right side.

As shown in Figure 4, the Series 4000 Oscillator consists basically of a main chassis with its own power supply in the rear and five or six plug-in modules. These modules which plug into the Series 4000 Oscillator Master Card PC407, include a Power Supply Module M401, a Square Wave and Pulse Module M402 or Square Wave Module M403 (both optional), two Amplifier Modules M404, a Main AVC Module M405, and a Reference AVC Module M406.

The Digital Controller also consists basically of a similar main chassis with its own power supply in the rear. A maximum of eight plug-in modules can be accommodated by the Master Card PC414 in the Digital Controller. As shown in Figure 4, the position of the three different types of modules; Frequency, Multiplier and Amplitude, depends on the options that are chosen. In the standard Programmable Oscillator, the first and second stations of the Digital Controller Master Card PC414 are used for the two Multiplier Modules, the third, fourth and fifth stations are used for the Frequency Modules and the remaining three stations are unused. If three digits of optional programmed amplitude, were needed the last three stations would be used for the Amplitude Modules.

If for example, four digits of frequency and three of amplitude were required, it would be necessary to use the alternate Master Card PC411. Since there are only eight stations on the Master Cards, the Programmable Oscillator would be limited to three frequency multiplier bands maximum, since only one station remains available for a Frequency Multiplier plug-in Module.

Component layouts and parts lists for the main chassis assemblies and all of these plug-in modules are included with their schematics at the end of this manual. Access to the Programmable Oscillator is accomplished easily without any hand tools by removing the top and bottom covers. It is first necessary to loosen (not remove) the two black thumb screws centered on each side at the rear of the chassis and then pull out the two side covers. This unlocks the top and bottom covers which then may be pulled out.

4.2 GENERAL

This Programmable Oscillator is a relay-operated form of the standard Krohn-Hite Series 4000 Oscillator. The manual controls which are used, in the Series 4000 Oscillator to vary frequency, frequency decade multiplier and amplitude are replaced by relays which can be programmed or controlled remotely.

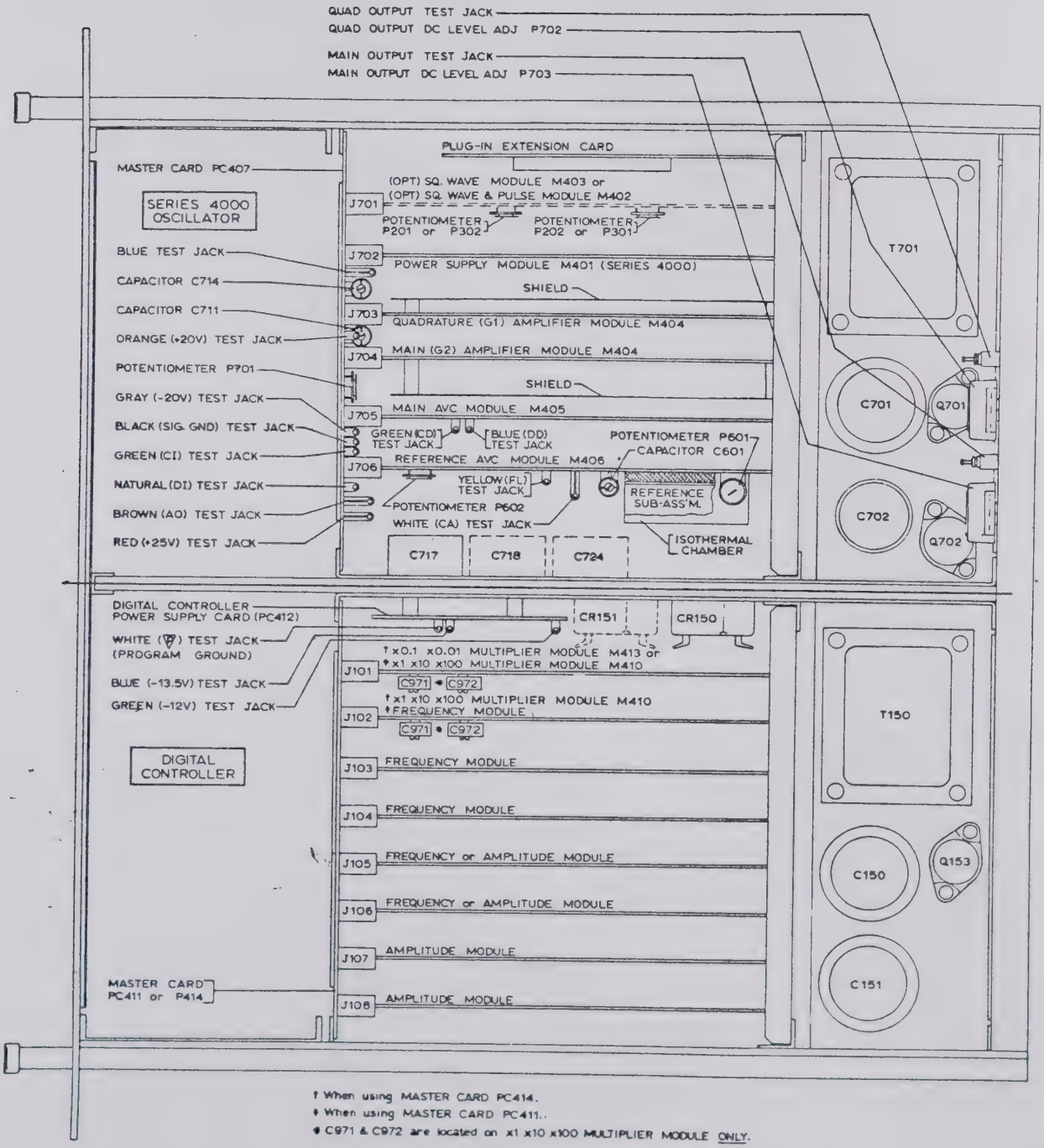


Figure 4. Top View of Main Assembly

In the standard Programmable Oscillator three digits for frequency are provided. Each digit of frequency is formed from the standard binary coded decimal 1-2-4-8 system. As shown in the Schematic Diagram of the Frequency Module Figure 17, each frequency digit consists basically of four relays and associated circuitry, mounted on a printed circuit plug-in module, coded to the numerals 0 (reset), 1, 2, 4 and 8, which are operated in the combinations required to generate the integers one through nine.

In the standard Programmable Oscillator there are two Frequency Multiplier plug-in Modules with appropriate relays, circuitry and frequency determining capacitors to control frequency in four decade multiplier bands of X100, X10, X1 and X0.1. An additional fifth multiplier band of X0.01 is optionally available. The Schematic Diagram of the X100, X10 and X1 band Multiplier Module is shown in Figure 18, and the Schematic Diagram of the X0.1 and X0.01 (optional) band Multiplier Module is shown in Figure 19. The X100 band multiplier position is also used as the reset position for the frequency multiplier.

Although a manual amplitude control is used in the Standard Programmable Oscillator, programmed amplitude with a maximum of four digits of resolution is available as a standard option. As shown in the Schematic Diagram of the Amplitude Module, Figure 20, each digit of amplitude also consists basically of four relays mounted on a printed circuit plug-in module. Figure 14 shows the interconnections between the printed circuit connectors of these four Amplitude Modules and the PROGRAM INPUT connector located on the rear of the chassis.

4.3 PRELIMINARY CHECKS

Many troubles may easily be found by visual inspection. When a malfunction is detected, make a quick check for broken wires, burnt or loose components, or similar conditions which could cause trouble. It is desirable to check the line voltage coming into the chassis and the fuses located on both the front panel and rear of the chassis. The correct type and rating of each fuse is shown adjacent to each fuse holder. The most frequently used check points have been provided with test jacks. These jacks are color coded and are identified as shown in Figure 4.

When a problem is encountered, it should first be determined if the malfunction is present under all conditions, or is present under certain conditions. Problems on certain multiplier bands or on certain frequency positions will usually be caused by something in the tuning network. If the trouble is on one particular multiplier band, the faulty component is probably one of the tuning capacitors associated with that band. If the trouble appears only at a particular frequency setting, the problem is most likely one of the resistors associated with that setting. This automatically isolates the problem to the Digital Controller since all of the frequency determining components are mounted on the plug-in modules in the Digital Controller. If the frequency determining resistors are suspected refer to Section 4.8, and if the frequency determining band capacitors are in question, refer to Section 4.9. The procedure for frequency selection or programming is outlined in Section 2.3, and Section 5.7 provides a convenient table showing the necessary pin connections of the PROGRAM INPUT connector for obtaining five specified frequencies.

Before beginning troubleshooting it should be determined if the normal adjustments mentioned in Calibration and Adjustment procedure, Section 5, will correct the trouble. Any troubleshooting of this Programmable Oscillator will be greatly simplified if there is an understanding of the operation of the circuit. Before any detailed troubleshooting is attempted, reference should be made to Circuit Description, Section 3.

There are two independent and isolated power supplies in the Model 4030R Programmable Oscillator, one for the Series 4000 Oscillator and one for the Digital Controller. Check the three Series 4000 Oscillator dc power supply voltages, +25 vdc (red test jack), +20 vdc (orange test jack) and -20 vdc (grey test jack) with respect to chassis ground. Because of the floating ground provision, measurements to chassis should not be done until the

Floating/Chassis grounding switch, located at the rear of the chassis, is in the Chassis position.

Check the two Digital Controller dc power supply voltages, -13.5 vdc (blue test jack) and -12 vdc (green test jack) with respect to the adjacent white test jack which is program ground. All of these supplies except the -12 volt unregulated supply should be within ±5% of their nominal value. If these supplies are out of tolerance, refer to Section 4.5. The -12 volt unregulated supply will vary with line voltage and also with the number of relays energized in the Amplifier Modules. With a nominal line voltage of 115 or 230 volts variations of ±30% in the -12 volt supply is normal.

If these supplies are correct, the Main and Quadrature output dc levels should be checked. To eliminate any ac signals when making these measurements connect a 0.02 uf capacitor in series with a 1200 ohm resistor from the blue test jack on the Series 4000 Oscillator Master Card (caution: there is also a blue test jack DD on the main AVC Module, M405) to chassis ground. Also remove the Reference AVC Module, M406, and ground the brown test jack (AO). These dc levels should both be within less than ±0.1 volt. Screwdriver controls and associated test jacks are provided at the rear of the chassis for monitoring and adjusting these levels. If the correct levels can not be obtained, the trouble is probably in either the G1 or G2 Amplifier Modules, M404. If the levels are both off in the same direction (either plus or minus), the trouble is probably in the G1 Amplifier Module. If the dc levels are off in different directions (one plus and one minus), the trouble is probably in the G2 Amplifier Module. When the trouble has been isolated to a particular amplifier module, reference should be made to Section 4.6. If the Main and Quadrature output dc levels are correct, a signal tracing analysis should be used to find the source of trouble.

4.4 SIGNAL TRACING

Connect an external signal source as shown in Figure 5. This source should be capable of providing a 10 volt rms sine wave into a 1000 ohm load at 1kHz. The reference AVC Module, M406 should remain out of the unit and the brown test jack (AO) should remain grounded for this check. Adjust the external source to provide 8.1 volts rms, and check the Quadrature output voltage. This should be a sine wave with an amplitude of approximately 10 volts rms. If this signal is incorrect, the trouble is probably in the G1 Amplifier Module. If the Quadrature signal is correct, check the Main Output voltage. This should also be a sine wave of approximately 10 volts rms amplitude. If this signal is incorrect, the trouble is probably in the G2 Amplifier Module. When the trouble has been isolated to a particular amplifier module, reference should be made to Section 4.6.

The Main and Quadrature output should be approximately 90 degrees out of phase. If this phase relationship is not correct there may be a problem in the tuning network. Check the frequency determining components that are located on the Modules in the Digital Controller. Use the procedure described in Section 5.6. If both the Main and Quadrature output signals appear to be correct, the trouble is probably in the AVC section of the Programmable Oscillator. In this case, reference should be made to Section 4.7.

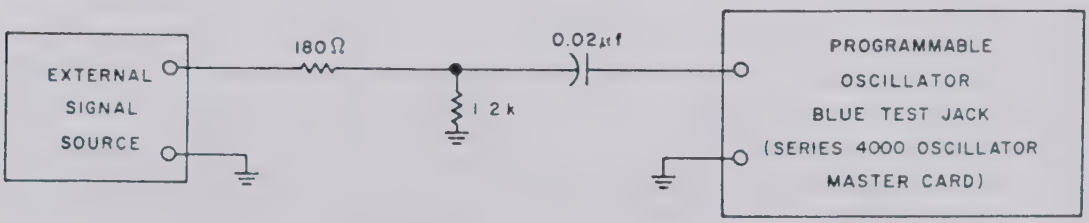


Figure 5. Circuit for External Signal Application

4.5 POWER SUPPLY

There are two independent and isolated power supplies in the Programmable Oscillator, one for the Series 4000 Oscillator and the other for the Digital Controller. Figure 4 shows the location of the major components and subassemblies for these supplies. The power transformers, filter capacitors, full-wave rectifiers and series regulator power transistors for both supplies are positioned at the rear of the main chassis and the two regulating amplifiers of these supplies are remotely located module subassemblies positioned as shown in Figure 4. The regulating amplifier for the Series 4000 Oscillator is a plug-in Module M401 whose Schematic is shown in Figure 10. The Schematic Diagram of the Digital Controller power supply is located on the lower left side of the Main Assembly Drawing, Figure 14, and its regulating amplifier consists of Module PC412 which is not a plug-in module.

The Series 4000 Oscillator Power Supply consists of three separate supplies of +25 volts, +20 volts, and -20 volts. The +25 is used as a reference supply for the -20, and the -20 is used as a reference supply for the +20. This fact should be kept in mind when doing any work on the supply, as a malfunction in the +25 will be reflected in the other two, and a malfunction in the -20 will be reflected in the +20. If the other supplies do not seem to be working properly, the +25 should be checked before beginning work on them; if the +20 is not working, the -20 should be checked first. The three supplies have current limiting circuits which will shut down the supply if excessive current is being drawn from it. For this reason an apparent malfunction in the supply could be caused by an overload in one of the other circuits.

The Digital Controller Power Supply consists of a -13.5 volt regulated supply that is used to power the Frequency Modules and Frequency Multiplier Modules, and a -12 volt unregulated supply that is used only for powering the optional Amplitude Modules.

Nominal voltages for various points in all the supplies are given on the appropriate schematic diagrams. If a malfunction occurs the error signal thus developed should be traced through the circuit to find the faulty component. Let us suppose for example that the +25 volt supply in the Series 4000 Oscillator power supply was lower than normal. This would produce an error signal which would make both the base and emitter of Q103 more negative than normal. Because the base moves less than the emitter the total result is a lowering of the collector of Q103 from its normal value. The base of Q101 should then be made more negative than normal and the collector more positive. This will raise the base of Q701 and finally should correct the output level. Had there been a bad component somewhere in the circuit, this correcting action would have been blocked. The faulty component would then have been found at the point in the circuit where the action was blocked. The same basic method of troubleshooting described above may also be used in the other regulated supplies when a malfunction occurs.

If it becomes necessary to replace the reference zener Z101 in the Series 4000 Oscillator supply, the voltage of the +25 volt supply will probably have to be readjusted. This may be done by trimming R115. This supply should be trimmed until +25 volt supply is within ±5%. In the -13.5 volt Digital Controller Supply transistor Q150 is used as a zener reference. If it is necessary to replace this transistor the -13.5 volt supply may be out of tolerance and R154 should be varied to return this supply to its correct voltage.

4.6 AMPLIFIER MODULE

When a problem has been isolated to one of the two Amplifier Modules in the Series 4000 Oscillator, the other Amplifier Module should be removed from the unit so that there will be no interaction between the two during troubleshooting. If the G1 Module has been removed, the Quadrature output should then be tied to chassis ground. If the G2 Module has been removed, the Main output should be tied to chassis ground. In addition, the Reference AVC Module, M406 should be removed from the unit and the brown test jack (AO) should be tied to ground.

Under the above conditions, measure the dc output level of the Amplifier Module under test. This will be the Quadrature output for the G1 Amplifier Module and the Main output for the G2 Amplifier Module. If the level is greater than ±0.5 volt there is probably trouble in the Amplifier, and the dc error signal thus developed should be traced through the circuit. For example, if the output level is plus, the feedback should raise the gate of Q403A from its normal value of zero. Through the differential stage this will then cause the drain of Q403B to become more positive than the drain of Q403A. The collector of Q404 will then go more positive while the collector of Q406 will go more negative than their normal values. This should then lower the emitters of Q407 and Q408 and correct the output level. If a faulty component is present in the circuit, it will usually prevent this corrective action from taking place. The faulty component will be found at the point in the circuit where the correct action is blocked.

Most problems in the Amplifier will show up in a level check and the troubleshooting method described above may be used to find the problem. If all the levels seem to be right and the unit seems to be working but will not take a load, Q407 and Q408 should be checked.

If it becomes necessary to replace the dual field-effect transistor, Q403A and Q403B, the output dc level may have to be retrimmed for the new unit. With the same initial set up as given at the beginning of this section, check the dc level at the output of the Amplifier in question (Quadrature output for G1, Main output for G2). If this level is other than zero, and the level control will not correct it, R412 and R413 should be adjusted. One of these resistors should be zero ohms at all times. The other is then adjusted to provide zero output level. If the output is plus, an increase in R413 will correct it. If the level is negative, an increase in R412 will correct it. The adjustment should be made with the dc level control in the center of its range to give an optimum range of adjustment.

4.7 AVC CIRCUIT

If there appears to be trouble in the AVC circuit, remove the ground lead from the brown test jack (AO), insert the Reference AVC Module, M406 in the unit, and check various waveforms as follows:

The unit should remain set up for an external input signal as shown in Figure 5. The signal from the external source should be varied in amplitude so that the voltage of the Main output varies from 9 to 11 volts rms. It should be noted that the signal on the Main output will be somewhat distorted when at the extremes of this range. While making this variation the signal at the brown test jack (AO) should be observed. When the Main output is at 9 volts rms, the AO signal should be a square wave in phase with the Quadrature output with an amplitude of at least 3 volts peak-to-peak. When the output is at 11 volts rms, the AO signal should be a square wave out of phase with the Quadrature output with an amplitude of at least 3 volts peak-to-peak. As the output is varied through 10 volts, the AO signal should go through a null. If this action takes place, the AVC circuit is probably functioning properly.

If the AO signal is not correct, check the Follower output level (FO) located at the emitter of Q607. This should be a dc voltage of at least plus 4 volts when the Main output is at 9 volts rms, and at least minus 4 volts when the Main output is at 11 volts rms. As the output swings through 10 volts rms, the FO voltage should swing through zero. If the FO signal is correct but AO is not, the trouble probably lies in the balanced modulator or the AO output loop.

To determine if the modulator is operating properly, look at the signal on the base of Q609. When the Main output is made 9 volts rms the signal here should be a square wave in phase with the Quadrature output with an amplitude of at least 2 volts peak-to-peak. When the Main Output is made 11 volts rms the square wave should change phase and have an amplitude of at least 2 volts peak-to-peak. As the output is varied through 10 volts rms, the signal should go through a null. It should be noted that the dc level of this signal will

normally change as its amplitude and phase changes. If the proper signal does not appear, check that a drive signal is reaching the base of Q608. If a drive signal is present but the modulator does not seem to be working, check Q608 and its associated components. If one of these components is changed, the symmetry of the AO signal should be checked. If necessary it may be adjusted by trimming R652. The flatness of the AO signal should also be checked. If necessary an adjustment may be made by trimming R645. If the proper modulator signal is present but the correct AO signal is not, the trouble is probably in the AO output loop.

If there appears to be trouble in the AO output loop, measure the dc level of the brown test jack (AO). This should be at zero volts ±0.5 volt. If this level is not right and the control will not correct it, the error voltage thus developed should be traced through the feedback loop. Nominal voltages for various points in the loop are shown on the Reference AVC Schematic, Figure 13.

As an example of this method of tracing, let us assume that AO is plus. Through the feedback this will make the base of Q610 more plus than normal. This should make the collector of Q610 more negative than normal, the collector of Q612 more negative than normal, and finally the output level should be corrected. When trouble is encountered, the faulty component will usually be found at the point in the loop where this corrective action is blocked. If, for example, in the previous case Q612 had been defective, its collector would not have gone more negative than normal when the base of Q611 went more negative than normal. This would then have been the point in the loop where the corrective action was blocked.

If the voltage at FO does not vary properly as the output is changed, check the voltage across the Storage Capacitor (SC), C730, located as shown in Figure 4. This is a high impedance point and care should be taken not to load it while making measurements. The measuring equipment should have an input impedance of at least 10 megohms. SC should vary from at least plus 4 volts through zero volts to at least minus 4 volts as the main output is varied from 9 to 11 volts rms. If SC varies properly but the FO does not, check Q606 and Q607 and their associated components.

If SC is not varying properly, check the waveform of the Discharge Drive pulse (DD) at the blue test jack located on the Main AVC Module, M405. This should be as pictured in Figure 6. If the DD pulse is not correct, check the three signals used by the DD circuit to develop the DD pulse. The three signals used are E_1, E_2, and E_3. E_1 is the Quadrature output before the attenuator, E_2 is the Main output before the attenuator, and E_3 a sine wave 180 degrees out of phase with the Quadrature output having an amplitude of approximately 7 volts rms. E_3 is developed from E_1 using an amplifier consisting of Q501, Q502, and their associated components. If these signals are being fed to the DD circuit but there is no DD pulse, the trouble is probably in Q503 or Q504 or their associated components.

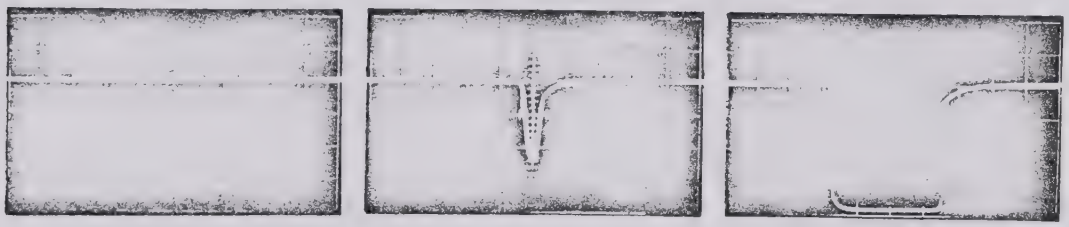
Vert-5v/cm Hor-50μs/cm

Figure 6. Discharge Drive Pulse

If any components are changed in the DD circuit or the E_3 amplifier, the position and width of the DD pulse should be checked. The DD pulse should then be approximately 18 degrees wide and should be centered about the Charge Drive pulse (CD) which is approximately 10 degrees wide when the Oscillator is functioning normally. R511 controls the start position of the DD pulse, R513 controls the stop position, and R514 controls the width.

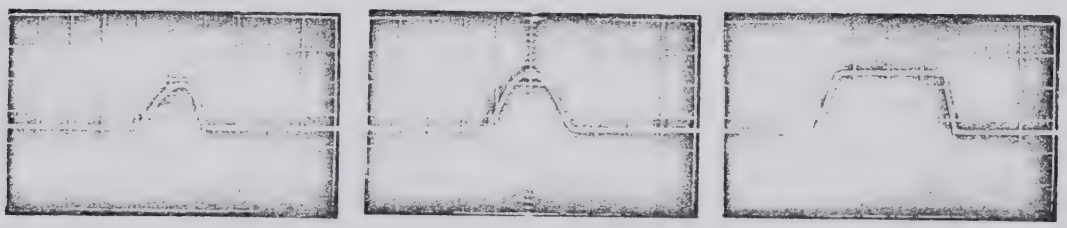
If the DD pulse appears to be correct, check the waveform of the Charge Drive pulse (CD) at the green test jack located on the Main AVC Module, M405. While looking at this point,

vary the Main output from 9 volts rms to 10 volts rms and then to 11 volts rms. The proper waveform of the CD pulse for these three conditions are shown in Figure 7. If these signals are not correct, check the waveform of the Charge Amplifier (CA) at the white test jack. The waveforms should be as shown in Figure 8 when the Main output is varied from 9 to 10 to 11 volts rms. If the CA is correct but CD is not, the trouble is probably in Q508, Q509, Q603 or Q604 or their associated components. If it becomes necessary to replace one of these components, R627 may have to be readjusted. To do this look at the FL signal at the yellow test jack. This should be as shown in Figure 9. R627 should then be adjusted so that the width of the lower portion of the signal is approximately 1.5 times the width of the upper portion. This adjustment should be made with the Programmable Oscillator in its normal operating condition (without the external signal).



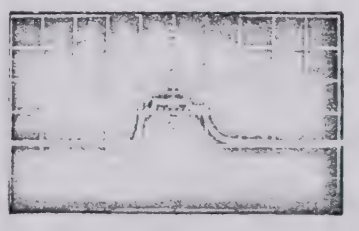
9 Volts 10 Volts 11 Volts

Figure 7. Charge Drive Pulse (CD) Shown when Main Output is at 9, 10 and 11 Volts rms. Vertical Sensitivity 5v/cm. Horizontal 50μs/cm.



9 Volts 10 Volts 11 Volts

Figure 8. Charge Amplifier Pulse (CA) Shown when Main Output is at 9, 10 and 11 Volts rms. Vertical Sensitivity 2v/cm. Horizontal Sensitivity 50 μs/cm.



Vert-0.5v/cm Hor-50μs/cm

Figure 9. FL Signal

If CA is not correct, check the various components associated with the reference sub-assembly, located on the Reference AVC Module, by removing the black plastic cover of the isothermal chamber. The problem may be in the reference zener Z601, diodes CR603, CR604, Q601 (used as a collector base diode), CR602, and amplifier Q602 or their associated components.

4.8 FREQUENCY MODULE

As shown in the Schematic Diagram of the Frequency Module, Figure 17, each digit of frequency consists basically of four relays. Each relay is driven by an emmitter follower which is switched by a silicon controlled rectifier. Actuation of each relay is accomplished by a contact closure from an appropriate pin on the program input connector at the rear of the chassis.

If a relay fails to operate the most likely source of trouble is either the silicon-controlled rectifier, the emitter follower or the relay itself. The failure can be isolated very quickly by using the following troubleshooting procedure:

1. Connect an ohmmeter from the center arm to the normally open contact of any relay in question.

2. Connect a jumper between the -13.5 volt supply and the base of the emitter follower transistor which is driving this relay. The correct nominal voltages at the emitters of all these relay driving emitter followers are alike and for simplicity sake is shown only at transistor Q902 in Figure 17. In the quiescent condition (without contact closure of any relay line) this emitter voltage, as measured with respect to programmed ground ▽P△, should be zero and the transistor should be cutoff. When the transistor is driven on by connecting its base to -13.5 volts this emitter voltage should be approximately -13 volts. If the emitter voltages are correct under this test the relay should function if it is not defective. Repeat this test for the other section of the relay.

3. To check whether the silicon-controlled rectifier (SCR) associated with the relay under test is functioning properly it is necessary to monitor its anode voltage. Again all of the correct nominal SCR anode voltages are alike and shown only at SCR901 in Figure 17. In the quiescent state this anode voltage should be zero with the SCR cutoff and should drop to approximately -12.7 volts when it is driven on. To turn the SCR on it is necessary to drive its gate positive with respect to its cathode. This can be done by connecting a jumper from the programmed ground ▽P△ to any one of the four (1, 2, 4 or 8) input lines. For example, if SCR901, which controls the numeral 8 relay, were under test it would be necessary to connect the above jumper from terminal 8 on the module input connector to program ground. This test should turn on SCR901 dropping its anode voltage to approximately -12.7 volts which in turn will activate the numeral 8 relay.

The procedure of connecting any relay line to the programmed ground is precisely what is required by the external programming device to control frequency remotely. If it was desired to program the 8 numeral in the 100 frequency digit the external programming unit would have to connect pin F on the program input connector to pin A which is program ground.

4. The reset circuitry in each of the Frequency and Amplitude Modules consist of a single switching transistor which is normally cut off with its collector at zero potential with reference to common or program ground. If the 0(reset) line is tied to program ground this collector voltage should drop to approximately -13.4 volts if the reset switching transistor is functioning properly.

Up to four digits of frequency are available and the value of the frequency determining resistors which are used in each setting of frequency is shown in the chart at the bottom of the Frequency Module Schematic, Figure 17. After determining which frequency setting is defective this chart should localize the faulty resistor.

4.9 FREQUENCY MULTIPLIER MODULES

There are two Frequency Multiplier Modules in the Standard Programmable Oscillator and they function in a similar manner to the Frequency Modules. Figure 18 is the Schematic of the X100, X10 and X1 decade Multiplier Module and Figure 19 is the Schematic of the X0.1 and X0.01 (optional) Multiplier Module. The frequency determining band capacitors which come into operation for each band multiplier position is shown in these Schematics. After determining which band is defective it is necessary to measure the value of the two frequency determining capacitors in each band to determine if they are in tolerance.

Additional relays in the Multiplier Modules shown at the bottom of the Schematics are used to switch in networks for individual band adjustments. They are adjusted by the final test department at our factory and should not be disturbed.

4.10 AMPLITUDE MODULE

The Amplitude Modules also use the same basic circuitry and function in the same manner as the Frequency Modules. Up to four digits of programmed amplitude is optionally available and the value of the resistors which come into operation for each setting of amplitude is shown in the chart on the bottom of the Amplitude Module Schematic, Figure 20. After determining which amplitude position is defective this chart should localize the faulty resistor.

4.11 AUTO/MANUAL

When the Programmable Oscillator contains optional front panel controls for manual selection of frequency, a front panel Auto/Manual toggle switch selects the desired mode of operation. As shown in the Auto/Manual Schematic Diagram, Figure 22, in the Manual position one section of this toggle switch disconnects terminal A of the programmed input connector from program ground ⏚ and connects it to the -13.5 volts. Since all of the relay lines are normally at -13.5 volts this makes the programmed input mode inoperative. The other section of this toggle switch connects the center arm of all the manual frequency and band multiplier decade switches to program ground which permits these decade band switches to control frequency in the manual position. In the Auto position this toggle switch connects the center arm of all the band switches to -13.5 volts which makes these manual controls inoperative. Figure 22 shows the wiring of a typical frequency and amplitude digit. This is repeated for as many digits as are required.

A series of switching diodes are used to isolate the two modes of operation. This isolation is accomplished by reverse biasing these switching diodes. Diodes D1 to D10 permit programmed information to function by disconnecting the effect of the manual switches. Manual operation without programming interference is obtained by diodes D11 to D20 which are in series with the programming input lines. Diodes D21 to D24 permit automatic reset in the manual mode with a choice of automatic reset or nonautomatic reset in the Auto Mode.

If the Programmable Oscillator does not function properly in the Manual mode but operates in the Auto mode (or alternatively functions in the Manual mode but not in the Auto mode), the most likely source of trouble is the switching diodes. If a diode is open the Programmable Oscillator will not function when the programming line or Manual decade switch position associated with that diode is closed since the diodes are in series with these control lines. This should localize a defective open diode. A shorted diode can be detected by monitoring the voltage across the 1K resistor R1 in series with the -13.5 volt supply and connected to the AUTO/MANUAL front panel toggle switch. If the same frequency that is programmed is also set manually the abnormal circulating current through the shorted diode will develop a voltage of approximately -13 vdc across R1. By checking the Programmable Oscillator under these conditions a shorted diode should be localized.

4.12 SQUARE WAVE AND PULSE

The Square Wave and Pulse Module, M402 and Square Wave Module, M403 depend on the Main sine wave output for their operation. If the Programmable Square Wave or Pulse does not seem to be working, check to see if the Oscillator is operating properly before attempting to troubleshoot the Square Wave or Pulse. The 4000 Series also offers a Square Wave only option in addition to the Square Wave and Pulse option. They both use basically the same circuit for the square wave. This procedure will deal mainly with the Square Wave and Pulse whose Schematic Diagram is shown in Figure 15. Part numbers in parenthesis will apply only to the Square Wave circuit, shown in Figure 16, so the same procedure may be used for that portion of the circuit.

The Programmable Oscillator should be set up as follows before beginning troubleshooting of the square wave or pulse:

1. Frequency at 1 kHz
2. Square Wave amplitude control at maximum cw
3. Function switch to square wave (if applicable)

If no Square Wave appears at the output, various waveforms should be checked as outlined below:

Reference should be made to Schematic Diagrams Figures 15 and 16. Check the waveform at point A. The signal here should be a square wave of approximately 9 volts peak-to-peak amplitude. If this signal is incorrect, the trouble is probably in Q207 (Q303) or Q208 (Q304) or their associated components. If point A appears to be correct, check the signal at point B. This also should be a square wave of approximately 9 volts peak-to-peak amplitude. If B is incorrect, the trouble is probably in Q209 (Q305) or Q210 (Q306) or their associated components.

With the correct signal at B, the waveform at C should be a square wave of approximately 4-5 volts peak-to-peak amplitude. Any discrepancy here would probably be caused by trouble in the multivibrator consisting of Q203 (Q301) and Q204 (Q302) and their associated components.

The waveform of point D should be a square wave of approximately 10 volts peak-to-peak amplitude when the correct signal is present at point C. If point D is not correct, the trouble is probably in the switching transistors Q201, Q202, Q205 or Q206 or their associated components. Since these switching transistors are omitted in the Square Wave Module, the output of the multivibrator (point C) is coupled directly to the output transistors. If the correct signal is present at point D but not at the output, check the output transistors Q214 (Q307) and Q215 (Q308) and their associated components.

The Pulse generator uses basically the same circuits as the Square Wave, therefore, before attempting to correct any problems with the Pulse, it should first be determined if the Square Wave is operating properly. If the Square Wave appears to be working, but the Pulse is not, the Oscillator should be set up as follows and various waveforms checked:

1. Oscillator Frequency at 1000 Hz
2. Square Wave/Pulse amplitude control at maximum cw
3. Function switch to plus 10 - 100 μs
4. Pulse width control maximum cw

Check the waveforms at point F. It should be a sawtooth with a peak amplitude of 3 volts. If the proper signal is not present at point F, check C801, C802, C803, S801, R801, P801, R204 and CR201.

Check the waveform at point G. It should be a negative pulse of approximately 5-10 volts peak coinciding with the trailing edge of the sawtooth. If the signal at point G is not correct, check the Schmidt Trigger consisting of Q211, Q212, and Q213 and their associated components. If the proper signal is present at point G and the output pulse is still not correct, check C207, R211 and CR205 to determine if triggering signals are being fed to the multivibrator.

SECTION 5

CALIBRATION AND ADJUSTMENT

5.1 INTRODUCTION

As shown in Figure 5, this Programmable Oscillator consists of the Standard Krohn-Hite Series 4000 Oscillator with the addition of the Krohn-Hite Digital Controller. The Series 4000 Oscillator is mounted on the left side of the chassis and the Digital Controller on the right side. The manual controls which are used in the Series 4000 to vary frequency, frequency decade multiplier and amplitude (optional) are replaced by relays which can be controlled remotely or programmed. These relays with their associated circuitry and the frequency determining components of the Series 4000 Oscillator are mounted on the appropriate plug-in modules in the Digital Controller.

The following procedure is provided for the purposes of facilitating the calibration and adjustment of the Programmable Oscillator in the field. The steps outlined follow very closely the operations which are performed on the instrument by our Final Test Department, and strict adherence to this procedure should restore it to its original specifications. It should be noted that some of the tolerances given in this procedure are much tighter than our general specifications. This is to ensure, in test, that all general specifications are met with adequate safety factor. These nominal tolerances, therefore, should not be used for purpose of accepting or rejecting the instrument. If any difficulties are encountered, please refer to Maintenance, Section 4. If any questions arise which are not covered by this procedure, please consult our Factory Service Department. The location of all major components, module sub-assemblies, test jacks, screwdriver controls and adjustments are shown in Figure 4.

Access to the Programmable Oscillator is accomplished easily without any hand tools by removing the top and bottom covers. It is first necessary to loosen (not remove) the two black thumb screws centered on each side at the rear of the chassis and then pull out the two side covers. This unlocks the top and bottom covers which then may be pulled out.

5.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform these tests:

a. Oscilloscope - having direct coupled horizontal and vertical amplifier with at least 10mv/cm sensitivity and a band width of 30 MHz, Tektronix type 545 or equivalent.

b. Differential Comparator Plug-In Unit, Tektronix Type W or equivalent.

c. Wide Band Plug-In Unit, Tektronix Type 1A1 or equivalent.

d. Precision Frequency and Period Counter - capable of measuring frequency from 100 Hz to 100 kHz and period from 1000 seconds to 1.0 millisecond.

e. Vacuum Tube Voltohmmeter - reading to 500 volts dc. Do not use this instrument for ac signal measurements.

f. Precision AC Differential Voltmeter, capable of measuring voltages from 10 mv to 10 volts rms from 30 Hz to 50 kHz with ±0.1% accuracy. Fluke Model 931P or equivalent.

g. Variable auto-transformer - to adjust the line voltage from 105 to 125 volts.

h. Distortion Meter and/or Wave Analyzer - capable of measuring distortion below 0.01% from 20 Hz to 20kHz, B&K Models 1607 and 2107 or equivalent.

i. AC Voltage Monitor - Krohn-Hite Model AC-601R or equivalent.

j. Phase meter capable of measuring phase angle to within 1 degree.

k. Strip Chart Recorder having 10 mv full scale sensitivity.

l. Thermal Transfer Voltmeter, Holt Model 6 or equivalent.

5.3 POWER SUPPLY OPERATION

With the Programmable Oscillator operating at 115 volts line, check the following dc voltages. The Floating/Chassis grounding switch located on the rear of the chassis should be in the Chassis position. All test jacks are color coded and their locations are shown in Figure 4.

Test Point	Voltage & Tolerance
Red test jack on Series 4000 Oscillator Master Card	+25 vdc ±5%, referred to chassis ground
Orange test jack on Series 4000 Oscillator Master Card	+20 vdc ±5%, referred to chassis ground
Gray test jack on Series 4000 Oscillator Master Card	- 20 vdc ±5%, referred to chassis ground
Blue test jack* on Digital Controller power supply card PC-412	-13.5 vdc ±5%, referred to adjacent white test jack* (program ground)
Green test jack* on Digital Controller power supply card PC-412	-12 vdc ±30%, referred to adjacent white test jack* (program ground)

*These test jacks are available only in units with Serial No. 136 and above.

5.4 DC LEVEL ADJUSTMENTS

Adjust all dc level controls to zero ±10 mv, in the following order:

Test Point	Control
1. Brown test jack (AO) on Series 4000 Oscillator Master Card	P602 located on Reference AVC Module, M406
2. Main output test jack on rear of chassis	P703 located on rear of chassis
3. Quadrature output test jack on rear of chassis	P702 located on rear of chassis

5.5 DISTORTION ADJUSTMENT

Set the Programmable Oscillator frequency to 20 Hz by connecting the program input connector pins [redacted] and [redacted] simultaneously to pin A which is programmed ground. Connect a high sensitivity oscilloscope (at least 10mv/cm) to the brown test jack (AO) on the Series 4000 Oscillator Master Card. Adjust P701 located on Series 4000 Oscillator Master card for minimum AO signal. This AO signal is a square wave and should be less than 10 mv peak-to-peak. Ignore the spikes which occur at the leading and trailing edges of this square wave. Repeat this test at 200 Hz, which is obtained by connecting pins c, D, H and N simultaneously to pin A, at 2 kHz by connecting pins b, D, H and N simultaneously to pin A, and at 20 kHz by connecting pins a, D, H and N simultaneously to A. The AO signal should be less than 10 mv at all frequencies up to 20 kHz. If it is not, readjust P701 for optimum setting.

Set the Programmable Oscillator frequency to 9.99 kHz by connecting pins b, C, F, J, M, P and T simultaneously to pin A. Adjust C714 located on the Series 4000 Oscillator Master card for minimum AO signal. This AO signal should be less than 10 mv peak-to-peak.

Set the Programmable Oscillator frequency to 50 kHz by connecting pins a, C, E, H and N simultaneously to A. Adjust C711, located on the Series 4000 Oscillator Master card, for minimum AO signal. This AO signal should be less than 30 mv peak-to-peak.

5.6 10 kHz FREQUENCY AND PHASE ADJUSTMENT

Set the Programmable Oscillator frequency to 10 kHz by connecting pins a, C, H and N simultaneously to pin A. Check the frequency calibration using a frequency counter, at the same time monitoring the phase relationship between the Main output and the Quadrature output. If the frequency is off calibration by more than ±0.5%, and the phase relationship is 90 degrees, adjust both trimmer capacitors C971 and C972, located on the X100, X10 and X1 Frequency Multiplier plug-in Module, in the same direction by approximately equal increments to correct the frequency without affecting the phase angle. If the frequency calibration is within ±0.5%, and the phase angle is out of tolerance, adjust C971 and C972 in opposite directions by equal increments. With a frequency counter and phase meter, check the frequency calibration and phase relationship of the Main output and the Quadrature output at other frequencies. If any frequency is out of tolerance, refer to Maintenance, Section 4.

5.7 DISTORTION

It is recommended that the total harmonic distortion be checked at the following frequencies on both the Main and Quadrature outputs:

Frequency	Connector Wiring	Tolerance	
		Main Output	Quadrature Output
20 Hz	d, D, H and N to A	0.01%	0.03%
100 Hz	c, C, H and N to A	0.01%	0.03%
1 kHz	b, C, H and N to A	0.01%	0.03%
10 kHz	a, C, H and N to A	0.01%	0.03%
20 kHz	a, D, H and N to A	0.01%	0.03%

Equipment that will measure distortion of this order of magnitude below 20 Hz is not known to be commercially available, therefore, this procedure does not cover the measurements beyond this range.

From 20 Hz up, this can be done fairly successfully by using a wave analyzer (GR, HP, B&K or Marconi) and a pre-filter (B&K and Marconi). Most manufacturers of wave analyzers have the same specification -1% full scale on the most sensitive range with a 10 volt input signal and internal distortion of about 0.03%. If the pre-filter is set to attenuate the fundamental amplitude, say 60 db, to almost the level of the harmonics, then the analyzer sensitivity can be increased until the largest harmonic is full scale at the new sensitivity. Assume 0.01% second harmonic distortion only. The analyzer is calibrated for an input level (fundamental + harmonic) of 10 volts. When the analyzer is set to the second harmonic frequency, the meter sensitivity only can be increased to 1% full scale (0.1 volts) from 100% full scale or 10 volts. Since the residual analyzer distortion is 0.03%, the example value of 0.01% will not be measurable. Now, if we add a pre-filter and attenuate the fundamental, 40 db, the analyzer input sensitivity can be increased 40 db for a full scale meter sensitivity of 0.01% and we can now read our theoretical second harmonic value of 0.01% with good accuracy.

Below 20 Hz, Krohn-Hite uses a noise meter type of instrument which has practically no residual distortion in the internal amplifiers - much less than the 0.03% specification of commercial analyzers and distortion meters, and which has an extremely sharp null. Because of the difficulty of achieving a very sharp null at low frequencies, the instrument is not continuously tunable but is fixed tuned at certain selected frequencies.

5.8 ATTENUATOR CALIBRATION

The amplitude control in the standard Programmable Oscillator is manual and consists of a single decade switch attenuator plus concentric vernier. Set the Oscillator frequency to 1 kHz by connecting pins b, C, H and N simultaneously to A. Using an ac voltmeter with better than 0.25% accuracy, check the calibration of the attenuator with the Vernier off (maximum ccw). The calibration accuracy should be within ±2% of indicated attenuator setting ±2 millivolts.

If optional programmed amplitude is incorporated in the Programmable Oscillator set the amplitude to 8.000 volts by connecting pins n, p, v, and AA simultaneously to A. Connect a high accuracy differential voltmeter (Fluke Model 931P or equivalent) to Main output of the Programmable Oscillator. Set the Programmable Oscillator frequency to 1 kHz by connecting pins b, C, H, and N simultaneously to A. Adjust potentiometer P601, located on the Reference AVC Module which is in the Series 4000 Oscillator, for a voltage reading of exactly 8.000 volts. Set the Programmable Oscillator frequency to 99.9 kHz by connecting pins a, C, F, J, M, P and T simultaneously to A and adjust C601 trim capacitor, also located on the Reference AVC Module, for a voltage reading of exactly 8.000 volts.

Set the Programmable Oscillator frequency back to 1 kHz. Check the calibration of the attenuator at other voltage settings. The accuracy should be within ±0.25% of indicated attenuator setting ±1 millivolt.

5.9 FREQUENCY RESPONSE

Using a thermocouple voltmeter, such as the Holt Thermal Transfer Voltmeter, Model 6, compare the main output voltage versus frequency from 20 Hz to 20 kHz, it should be within ±0.1%. The absolute voltage accuracy is not important because only changes in voltage are observed. AMPLITUDE 8.00 V.

Below 20 Hz it is necessary to check the frequency response, using an ac-dc voltage comparator such as the Rotek Model 212H.

5.10 AMPLITUDE STABILITY

The long term amplitude stability may be monitored by using a suitable ac voltage monitor such as the Krohn-Hite Model AC601R and a sensitive strip chart recorder. Connect the output of the Programmable Oscillator prior to the output attenuator to the input of the AC Monitor. Set the Oscillator frequency to 1 kHz. Set the input voltage controls on the AC Monitor to 10 volts. Connect the output of the AC Monitor to the input of a strip chart recorder. Adjust the input voltage controls on the AC Monitor for a null on the recorder at maximum sensitivity. When using the Krohn-Hite Model AC601R in the maximum sensitivity (0.01%) position, a 0.01% change in input voltage will produce a 0.5 millivolt dc change in the output of the monitor. With a recorder having a full scale sensitivity of 10 millivolts, changes in ac voltages of 0.001% can be observed.

5.11 HUM AND NOISE (Cycle-to-Cycle Stability)

This specification can be checked by using a Tektronix scope with a type W differential comparator type plug-in unit or equivalent. Using 1 millivolt per centimeter sensitivity, check the cycle-to-cycle peak amplitude variations with the Programmable Oscillator at 1 KHz and the output at 7 volt rms. The peak variations should be less than 1 cm (1mv). The total hum and noise can also be observed on the peak of the waveform.

5.12 HUM MODULATION

Using the same method as above in step 5.11, check the line frequency modulation or beat at 63 Hz by connecting pins ~~C, D, E, J, K and N~~ simultaneously to pin A, and 123 Hz by connecting pins ~~C, B, K, P~~ and ~~R~~ simultaneously to pin A. The maximum peak excursion should be less than ~~1~~ cm (1mv).

B, K
P, R

C, C, K, P, R

5.13 OUTPUT IMPEDANCE

Connect the 600 ohm output to an ac voltmeter. Adjust the output attenuator for a reading of 8 volts. Load the output with 600 ohms. The output voltage should drop to 4 volts. Repeat this check on the 200 ohm output using a 200 ohm load. This check can be performed at various attenuator settings. In each case the output voltage should drop 6 db when shunted with the matched load.

5.14 EXTERNAL SYNCHRONIZATION

Connect a 1 kHz external signal of 1/4 volt rms amplitude to the Programmable Oscillator SYNC input connector located on the rear of the chassis. Set the Programmable Oscillator to 1 kHz. Connect the Main output of the Programmable Oscillator to the vertical amplifier of the scope and connect the external Oscillator to the horizontal amplifier of the scope. Set the scope up for display of a circular Lissajous pattern. The Programmable Oscillator should lock to the external signal over a range of approximately ±0.5% of its frequency setting.

5.15 SQUARE WAVE ADJUSTMENTS (Where Applicable)

5.15.1 Symmetry

Using a wide-band Oscilloscope (frequency range at least 30 MHz) connect the scope lead with a 50 ohm termination to the Square Wave output of the Programmable Oscillator. Set the Programmable Oscillator frequency to 99.9 kHz and Function switch to "square wave".

Set the square wave amplitude control full CW. While observing the square wave symmetry adjust Potentiometer P201, located on the Square Wave and Pulse Module, or P301 located on the Square Wave Module, for a 1% symmetrical waveform.

5.15.2 DC Level

Adjust Potentiometer P202, located on the Square Wave and Pulse Module or P302, located on the Square Wave Module, for zero dc level on the Square Wave output. This can be observed on the scope or by using a dc voltmeter connected to the square wave output terminal.

5.15.3 Rise and Fall Time

Using a 30 MHz bandwidth oscilloscope, with the sweep time calibrated for 20 nanoseconds per centimeter, measure the rise and fall time of the Square Wave at 99.9 kHz. The rise time is considered to be the horizontal displacement between the 10% and 90% points. The tolerance is less than 20 nanoseconds.

5.16 PULSE WIDTH (When Applicable)

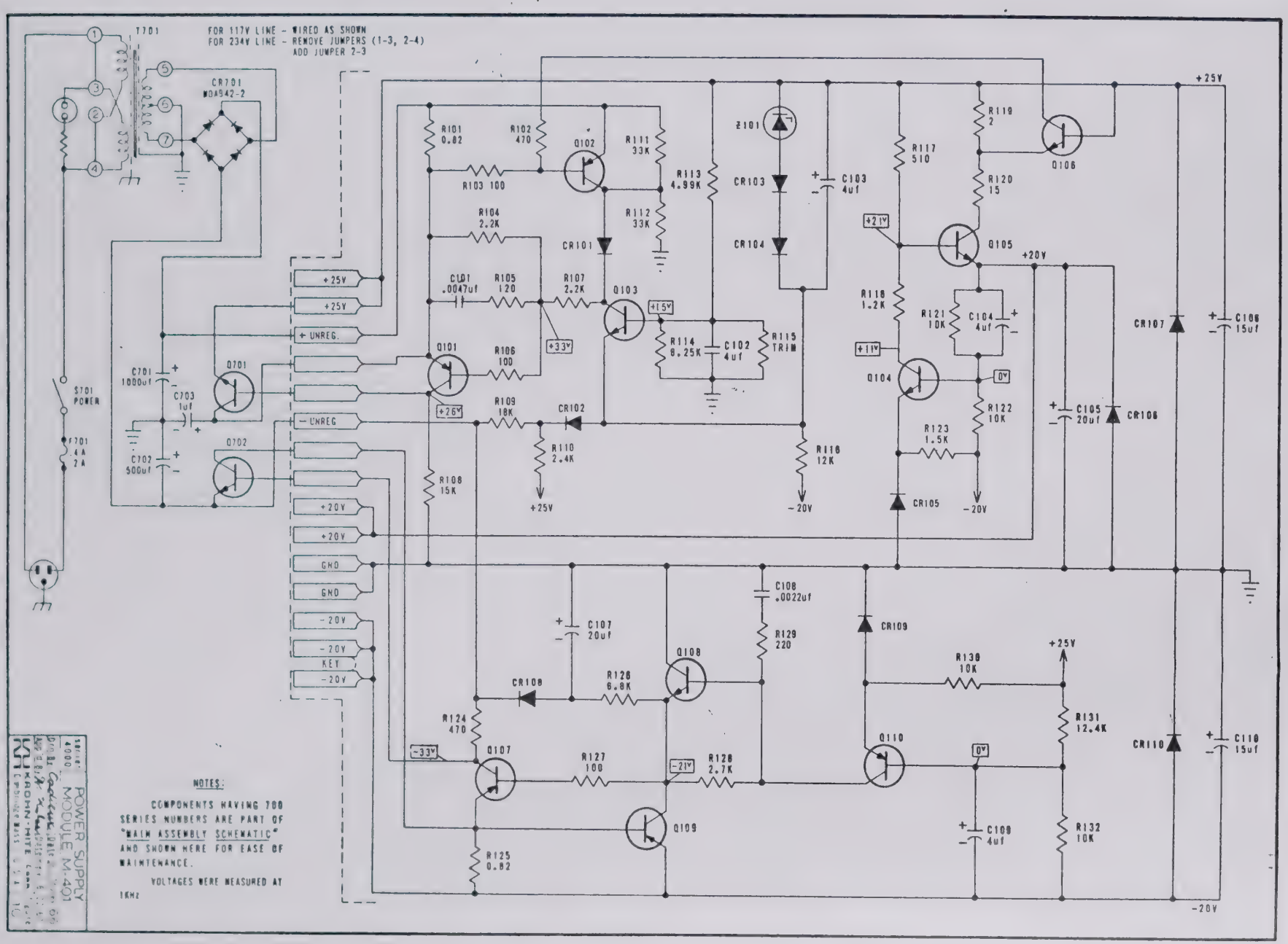
Using a calibrated sweep time on the oscilloscope, measure the Pulse width range in each position for both the negative and positive pulse. Each range should overlap so that there is continuous coverage from 0.1 microsecond to 100 microseconds.

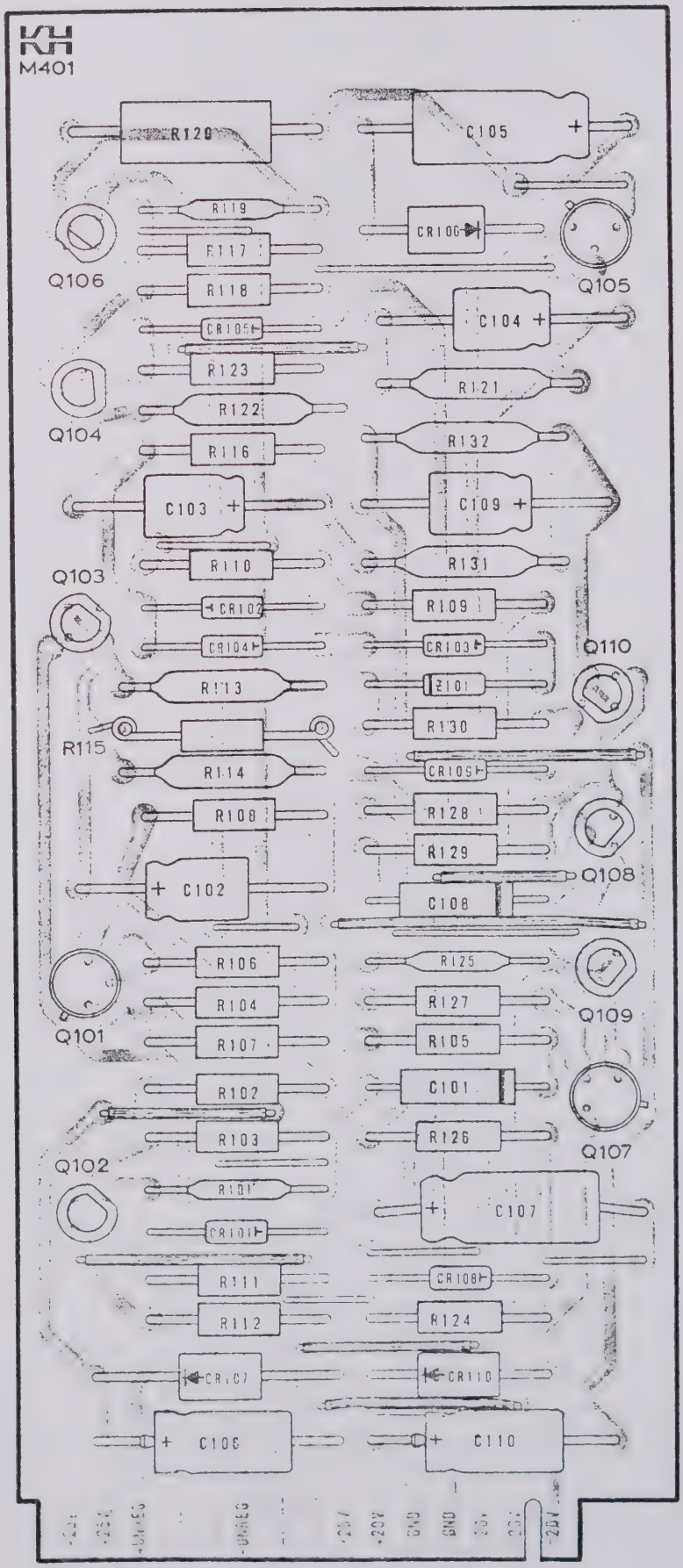
MODEL 4030R

MODEL 4031R

The following modifications and corrections are not reflected on the schematic and may be added at the discretion of the customer.

Starting with Serial No.	C.O. #	Corrections
Documentation	2438	(On Schematic dated 8/14/67 Fig. 14 - Main Ass'm. Schem. PC 407 & PC411) "Digital Controller Master Card" located above 10 freq. module & 1 freq. module should be PC411 (not PC414) Lower case (a) and (c) on the programming connector should be reversed. (This applies to Fig. 14 - PC407 & PC411 and to Fig. 14 - PC407 & PC414) Your manual contains one of Fig. 14 schematics - according to which instrument you have ordered.
Documentation	2465	On Schematic PC414 #14 C724 (10uf) should be wired from E2 to (6). C718 (10uf) should be wired from ground to (7). Add (6) to PC414. X.1 and X.01 Mult. Module Fig.#19 C724 (10uf) should be wired from E2 to (6). C718 (10uf) should be wired from ground to (7). Add (6) on X.1, X.01 Mult. Card. 7 and 6 were shown going to the wrong centerarms of K983 relay.


T701
FOR 117V LINE - WIRED AS SHOWN
FOR 234V LINE - REMOVE JUMPERS (1-3, 2-4)
ADD JUMPER 2-3
CR701
MDA942-2
S701
POWER
F701
4A
2A
C701
1000uf
C703
1uf
C702
500uf
Q701
Q702
+25V
+25V
+ UNREG.
- UNREG
+20V
+20V
GND
GND
-20V
-20V
KEY
-20V
R101
0.82
R102
470
Q102
R111
33K
R103 100
R113
4.99K
R112
33K
R104
2.2K
CR101
C101
.0047uf
R105
120
R107
2.2K
Q103
+15V
+33V
Q101
R106
100
+26V
R109
18K
CR102
R110
2.4K
+25V
R108
15K
R114
8.25K
C102
4uf
R115
TRIM
R116
12K
-20V
Z101
CR103
CR104
C103
4uf
R117
510
+21V
R118
1.2K
+11V
Q104
R119
2
Q106
R120
15
Q105
+20V
R121
10K
C104
4uf
0V
R122
10K
R123
1.5K
CR105
-20V
CR107
C106
15uf
C105
20uf
CR106
+25V
C108
.0022uf
R129
220
CR109
C107
20uf
Q108
R138
10K
+25V
CR108
R126
6.8K
R124
470
-33V
Q107
R127
100
-21V
R128
2.7K
Q110
0V
R131
12.4K
CR110
C110
15uf
Q109
C109
4uf
R132
10K
R125
0.82
-20V
NOTES:
COMPONENTS HAVING 700 SERIES NUMBERS ARE PART OF "MAIN ASSEMBLY SCHEMATIC" AND SHOWN HERE FOR EASE OF MAINTENANCE.
VOLTAGES WERE MEASURED AT 1KHz
POWER SUPPLY
MODULE M-401
KROHN-HITE


M401
R120
C105
R119
CR106
R117
Q106
Q105
R118
CR105
C104
R123
R121
R122
Q104
R116
R132
C103
C109
R110
R131
Q103
CR102
R109
CR104
CR103
Q110
R113
Z101
R130
R115
R114
CR109
R108
R128
R129
Q108
C102
C108
R106
R125
R104
R127
Q109
Q101
R107
R105
R102
C101
R103
R126
Q107
Q102
R101
C107
CR101
CR108
R111
R124
R112
CR107
CR110
C106
C110
-20V
+20V
GND
GND
-20V
+20V

RESISTORS

Symbol	Description			Mfr.	Part No.
R101	0.82	5%	1W	IRC	AS-1
R102	470	10%	1/2W	A-B	EB-4711
R103	100	20%	1/2W	A-B	EB-1012
R104	2.2K	10%	1/2W	A-B	EB-2221
R105	120	10%	1/2W	A-B	EB-1211
R106	100	20%	1/2W	A-B	EB-1012
R107	2.2K	10%	1/2W	A-B	EB-2221
R108	15K	10%	1/2W	A-B	EB-1531
R109	18K	10%	1/2W	A-B	EB-1831
R110	2.4K	5%	1/2W	A-B	EB-2425
R111	33K	10%	1/2W	A-B	EB-3331
R112	33K	10%	1/2W	A-B	EB-3331
R113	4.99K	1%	1/2W	IRC	CEC-TO
R114	8.25K	1%	1/2W	IRC	CEC-TO
R115	Trim	20%	1/2W	A-B	TYPE EB
R116	12K	10%	1/2W	A-B	EB-1231

Symbol	Description			Mfr.	Part No.
R117	510	5%	1/2W	A-B	EB-5115
R118	1.2K	10%	1/2W	A-B	EB-1221
R119	2	5%	1W	IRC	AS-1
R120	15	5%	2W	A-B	HB-1505
R121	10K	1%	1/2W	IRC	CEC-TO
R122	10K	1%	1/2W	IRC	CEC-TO
R123	1.5K	5%	1/2W	A-B	EB-1525
R124	470	10%	1/2W	A-B	EB-4711
R125	0.82	5%	1W	IRC	AS-1
R126	6.8K	10%	1/2W	A-B	EB-6821
R127	100	20%	1/2W	A-B	EB-1012
R128	2.7K	10%	1/2W	A-B	EB-2721
R129	220	10%	1/2W	A-B	EB-2211
R130	10K	10%	1/2W	A-B	EB-1031
R131	12.4K	1%	1/2W	IRC	CEC-TO
R132	10K	1%	1/2W	IRC	CEC-TO

CAPACITORS

Symbol	Description			Mfr.	Part No.
C101	0.0047mf	10%	100V	C-D	WMF-1D47
C102	4mf	+75% -10%	50V	SP	30D405G050 BA2
C103	4mf	+75% -10%	50V	SP	30D405G050 BA2
C104	4mf	+75% -10%	50V	SP	30D405G050 BA2
C105	20mf	+75% -10%	50V	SP	30D206G050 CC2

Symbol	Description			Mfr.	Part No.
C106	15mf	20%	50V	SP	150D156X0050 R2
C107	20mf	+75% -10%	50V	SP	30D206G050 CC2
C108	0.0022mf	10%	100V	C-D	WMF-1D22
C109	4mf	+75% -10%	50V	SP	30D405G050 BA2
C110	15mf	20%	50V	SP	150D156X0050 R2

TRANSISTORS, DIODES, & MISC.

Symbol	Description	Mfr.	Part No.
Q101	40319	RCA	40319
Q102	2N3703	TI	2N3703
Q103	2N3708	TI	2N3708
Q104	2N3711	TI	2N3711
Q105	40315	RCA	40315
Q106	2N3416	GE	2N3416
Q107	40319	RCA	40319
Q108	2N3711	TI	2N3711
Q109	2N3703	TI	2N3703
Q110	2N3702	TI	2N3702
CR101	1N456	TRANS	1N456

Symbol	Description	Mfr.	Part No.
CR102	1N456	TRANS	1N456
CR103	1N456	TRANS	1N456
CR104	1N456	TRANS	1N456
CR105	1N456	TRANS	1N456
CR106	1N3253	RCA	1N3253
CR107	1N3253	RCA	1N3253
CR108	1N456	TRANS	1N456
CR109	1N456	TRANS	1N456
CR110	1N3253	RCA	1N3253
Z101	1N935	SEM	1N935

MANUFACTURERS CODE

A-B	Allen-Bradley Co.	Milwaukee, Wis.	SEM	U.S. Semcor	Phoenix, Ariz.
C-D	Cornell-Dubilier Elec.	Newark, N.J.	SP	Sprague Electric Co.	North Adams, Mass.
GE	General Electric Co.	Syracuse, N.Y.	TI	Texas Instruments, Inc.	Dallas, Texas
IRC	International Resistance Co.	Philadelphia, Pa.	TRANS	Transitron Electric Corp.	Wakefield, Mass.
RCA	Radio Corp. of America	Harrison, N.J.			

RESISTORS

Symbol	Description			Mfr.	Part No.
R401	1K	10%	1/2W	A-B	EB-1021
R402	100K	5%	1/4W	A-B	CB-1045
R403	2,979.9	0.05%	3/10W	VI	S102
R404	2,979.9	0.05%	3/10W	VI	S102
R405	75K	5%	1/2W	A-B	EB-7535
R406	18K	5%	1/2W	A-B	EB-1835
R407	1K	10%	1/2W	A-B	EB-1021
R408	3.6K	5%	1/2W	A-B	EB-3625
R409	910	5%	1/2W	A-B	EB-9115
R410	2.7K	10%	1/2W	A-B	EB-2721
R411	15	5%	1/2W	A-B	EB-1505
R412	Trim			A-B	TYPE EB
R413	Trim			A-B	TYPE EB
R414	680	5%	1/2W	A-B	EB-6815
R415	14.7K	1%	1/2W	IRC	CEC-TO
R416	14.7K	1%	1/2W	IRC	CEC-TO

Symbol	Description			Mfr.	Part No.
R417	62	5%	1/2W	A-B	EB-6205
R418	62	5%	1/2W	A-B	EB-6205
R419	270	10%	1/2W	A-B	EB-2711
R420	10	5%	1/2W	A-B	EB-1005
R421	10	5%	1/2W	A-B	EB-1005
R422	100	20%	1/4W	A-B	CB-1012
R423	15K	5%	1/2W	A-B	EB-1535
R424	6.2K	5%	1/2W	A-B	EB-6225
R425	3.9K	5%	1/2W	A-B	EB-3925
R426	100	10%	1/2W	A-B	EB-1011
R427	10K	5%	1/2W	A-B	EB-1035
R428	10K	5%	1/2W	A-B	EB-1035
R429	2.4K	5%	1/2W	A-B	EB-2425
R430	2K	5%	1/2W	A-B	EB-2025
R431	15	5%	1/2W	A-B	EB-1505
R432	91K	5%	1/2W	A-B	EB-9135

CAPACITORS

Symbol	Description			Mfr.	Part No.
C401	1mfd	20%	35V	SP	150D105X0035A2
C402	1mfd	20%	35V	SP	150D105X0035A2
C403	33pf	5%	500V	EL	DM15C330J
C404	15pf	5%	500V	EL	DM15C150J
C405	24pf	10%	500V	EL	DM15C240K
C406	0.001mfd	10%	400V	C-D	WMF1D1
C407	24pf	10%	500V	EL	DM15C240K

Symbol	Description			Mfr.	Part No.
C408	1mfd	20%	35V	SP	150D105X0035A2
C409	1mfd	20%	35V	SP	150D105X0035A2
C410	0.01mfd	10%	100V	C-D	WMF1S1
C411	1mfd	20%	35V	SP	150D105X0035A2
C412	10pf	10%	500V	EL	DM15C100K
C413	0.01mfd	10%	100V	C-D	WMF1S1

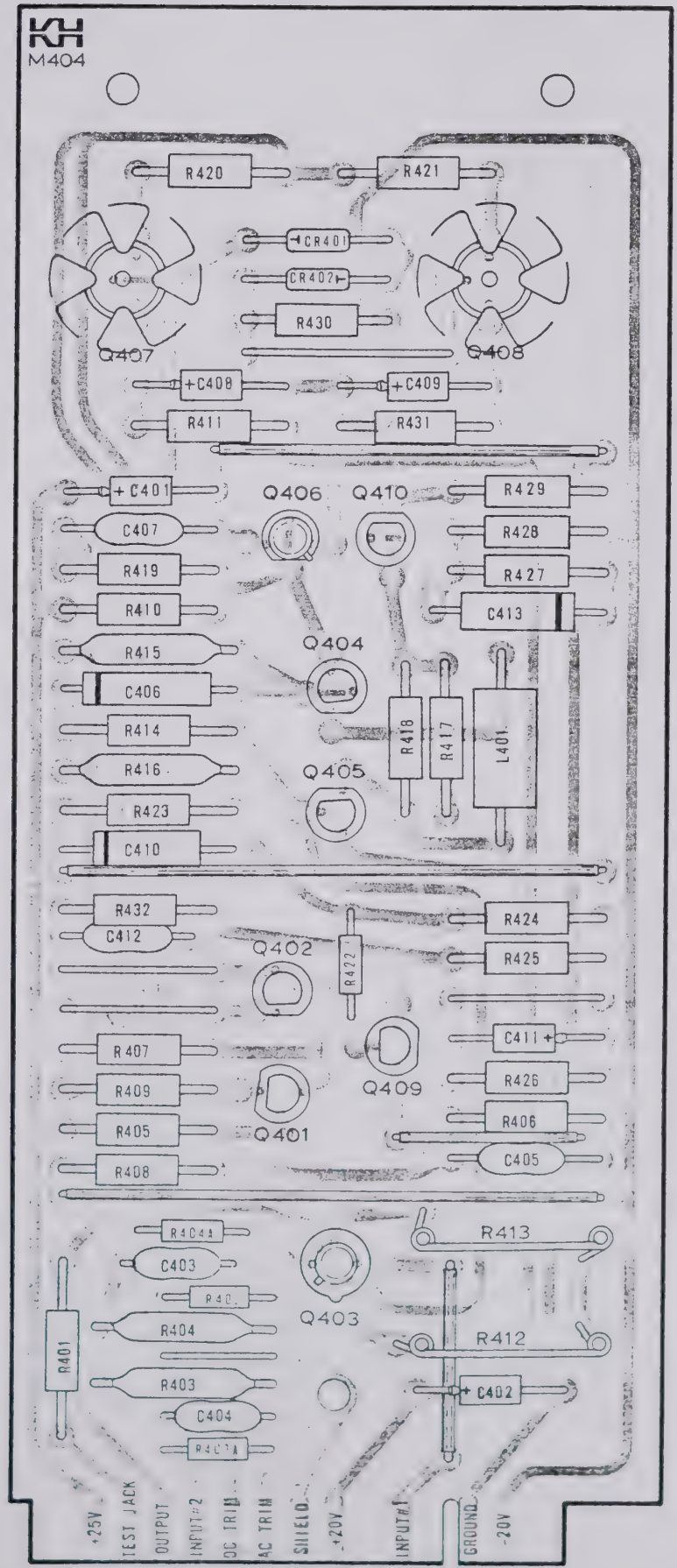
TRANSISTORS, DIODES, & MISC.

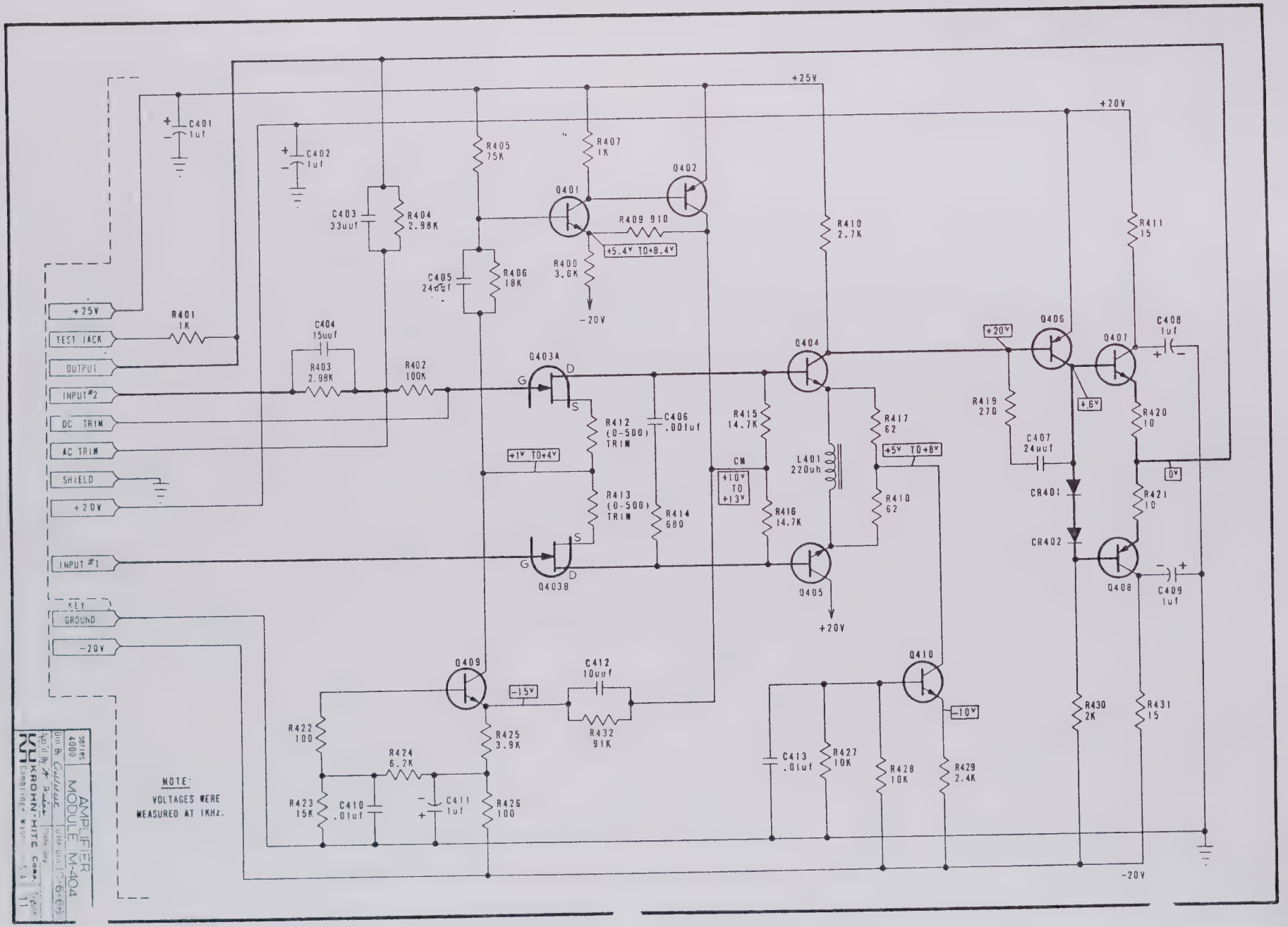
Symbol	Description	Mfr.	Part No.
Q401	2N3711	TI	2N3711
Q402	2N3703	TI	2N3703
Q403	FD1070	UC	FD1070
Q404	2N3711	TI	2N3711
Q405	2N3711	TI	2N3711
Q406	MM2005-2	MOT	MM2005-2
Q407	2N1711	RCA	2N1711

Symbol	Description	Mfr.	Part No.
Q408	40319	RCA	40319
Q409	2N3903	MOT	2N3903
Q410	2N3708	TI	2N3708
CR401	1N456	TRANS	1N456
CR402	1N456	TRANS	1N456
L401	220 uh	DEL	3500-16

MANUFACTURERS CODE

A-B	Allen-Bradley Co.	Milwaukee, Wis.	SP	Sprague Electric Co.	North Adams, Mass.
C-D	Cornell-Dubilier Elec.	Newark, N. J.	TI	Texas Instruments, Inc.	Dallas, Texas
DEL	Delevan Electronics	East Aurora, N. Y.	TRANS	Transitron Electric Corp.	Wakefield, Mass.
EL	Electro Motive Mfg. Inc.	Willimantic, Conn.	MOT	Motorola Semiconductor	Phoenix, Arizona
IRC	International Resistance Co.	Philadelphia, Pa.	UC	Union Carbide Electronics	Mountain View, Calif.
RCA	Radio Corporation of America	Harrison, N. J.	VI	Vishay Inst., Inc.	Malvern, Pa.


M404
R420
R421
CR401
CR402
R430
Q407
Q408
+C408
+C409
R411
R431
+C401
Q406
Q410
R429
C407
R428
R419
R427
R410
C413
Q404
R415
C406
R418
R417
L401
R414
R416
Q405
R423
C410
R432
C412
Q402
R422
R424
R425
R407
C411+
R409
Q409
R426
R405
Q401
R406
R408
C405
R404A
R413
C403
Q403
R401
R404
R412
R403
C402
C404
+25V
TEST JACK
OUTPUT
INPUT#2
DC TRIM
AC TRIM
SHIELD
-20V
INPUT#1
GROUND
-20V


+25V
+20V
C401 1uf
C402 1uf
R405 75K
R407 1K
Q402
Q401
C403 33uuf
R404 2.98K
R409 910
R410 2.7K
R411 15
+5.4V TO+8.4V
C405 24uuf
R406 18K
R400 3.6K
-20V
+25V
R401 1K
TEST JACK
OUTPUT
INPUT#2
DC TRIM
AC TRIM
SHIELD
+20V
INPUT #1
KEY
GROUND
-20V
C404 15uuf
R403 2.98K
R402 100K
Q403A
Q404
Q406
Q407
C408 1uf
+20V
+.6V
R419 270
R420 10
C407 24uuf
0V
CR401
CR402
R421 10
Q408
C409 1uf
C406 .001uf
R412 (0-500) TRIM
+1V TO+4V
R413 (0-500) TRIM
R414 680
Q403B
R415 14.7K
CM
+10V TO +13V
R416 14.7K
L401 220uh
R417 62
+5V TO+8V
R418 62
Q405
+20V
Q409
-15V
C412 10uuf
R432 91K
Q410
-10V
R422 100
R424 6.2K
R425 3.9K
R423 15K
C410 .01uf
C411 1uf
R426 100
C413 .01uf
R427 10K
R428 10K
R429 2.4K
R430 2K
R431 15
-20V
NOTE:
VOLTAGES WERE MEASURED AT 1KHz.
AMPLIFIER MODULE M-404
KROHN-HITE

RESISTORS

Symbol	Description	Mfr.	Part No.
R501	27K 10% 1/4W	AB	CB-2731
R502	680 10% 1/4W	AB	CB-6811
R503	20K 5% 1/4W	AB	CB-2035
R504.	1.2K 10% 1W	AB	GB-1221
R505	3.3K 10% 1/4W	AB	CB-3321
R506	5.1K 5% 1/4W	AB	CB-5125
R507	6.2K 5% 1/4W	AB	CB-6225
R508	8.2K 10% 1/4W	AB	CB-8221
R509	27K 10% 1/4W	AB	CB-2731
R510	4.7K 10% 1/4W	AB	CB-4721
R511	150K 10% 1/2W	AB	EB-1541
R512	4.7K 10% 1/4W	AB	CB-4721
R513	270K 10% 1/2W	AB	EB-2741
R514	68K 10% 1/2W	AB	EB-6831
R515	3.3K 10% 1/4W	AB	CB-3321
R516	100 20% 1/4W	AB	CB-1012
R517	2.7K 10% 1/4W	AB	CB-2721
R518	1K 10% 1/2W	AB	EB-1021
R519	1K 10% 1/4W	AB	CB-1021
R520	1K 10% 1/4W	AB	CB-1021
R521	4.7K 10% 1/4W	AB	CB-4721
R522	680 10% 1/4W	AB	CB-6811
R523	4.7K 10% 1/4W	AB	CB-4721
R524	1K 10% 1/4W	AB	CB-1021

Symbol	Description	Mfr.	Part No.
R525	22K 10% 1/4W	AB	CB-2231
R526	15K 10% 1/4W	AB	CB-1531
R527	100 20% 1/4W	AB	CB-1012
R528	2.2K 10% 1/2W	AB	EB-2221
R529	100 20% 1/4W	AB	CB-1012
R530	560 10% 1/4W	AB	CB-5611
R531	1K 10% 1W	AB	GB-1021
R532	220 10% 1/4W	AB	CB-2211
R533	1K 10% 1/4W	AB	CB-1021
R534	5.6K 5% 1/4W	AB	CB-5625
R535	1.1K 5% 1/4W	AB	CB-1125
R536	5.1K 5% 1/4W	AB	CB-5125
R537	6.8K 5% 1/4W	AB	CB-6825
R538	82K 10% 1/4W	AB	CB-8231
R539	22 5% 1/4W	AB	CB-2205
R540	390 5% 1/4W	AB	CB-3915
R541	2.2K 5% 1/2W	AB	EB-2225
R542	1K 5% 1/4W	AB	CB-1025
R543	1.8K 10% 1/4W	AB	CB-1821
R544	12K 10% 1/2W	AB	EB-1231
R545	1.5K 10% 1/4W	AB	CB-1521
R546	4.7K 10% 1/4W	AB	CB-4721
R547	220K 10% 1/4W	AB	CB-2241
R548	1.8K 5% 1/2W	AB	EB-1825

CAPACITORS

Symbol	Description	Mfr.	Part No.
C501	0.0047mf 10% 100V	CD	WMF1D47
C502	22pf f0% 500V	EL	DM15C22OK
C503	.022mf 10% 100V	CD	WMF1S22
C504	.1mf 10% 100V	CD	WMF1P1
C505	3mf 10% 100V	ELP	Z1X305K
C506	0.0022mf 10% 100V	CD	WMF1D22

Symbol	Description	Mfr.	Part No.
C507	180pf 10% 500V	EL	DM15C181K
C508	0.01mf 10% 100V	CD	WMF1S1
C509	0.0056mf 10% 100V	CD	WMF1D56
C510	0.47mf 10% 100V	ELP	Z1X474K
C511	0.33mf 10% 100V	ELP	Z1X334K

TRANSISTORS, DIODES, & MISC.

Symbol	Description	Mfr.	Part No.
Q501	2N3711	TI	2N3711
Q502	2N3703	TI	2N3703
Q503	MM2000-2	Mot	MM2000-2
Q504	2N3702	TI	2N3702
Q505	2N3708	TI	2N3708
Q506	2N3702	TI	2N3702
Q507	2N3702	TI	2N3702
Q508	2N3702	TI	2N3702
Q509	2N3704	TI	2N3704
CR501	1N456	Trans	1N456
CR502	SG5445	Trans	SG5445

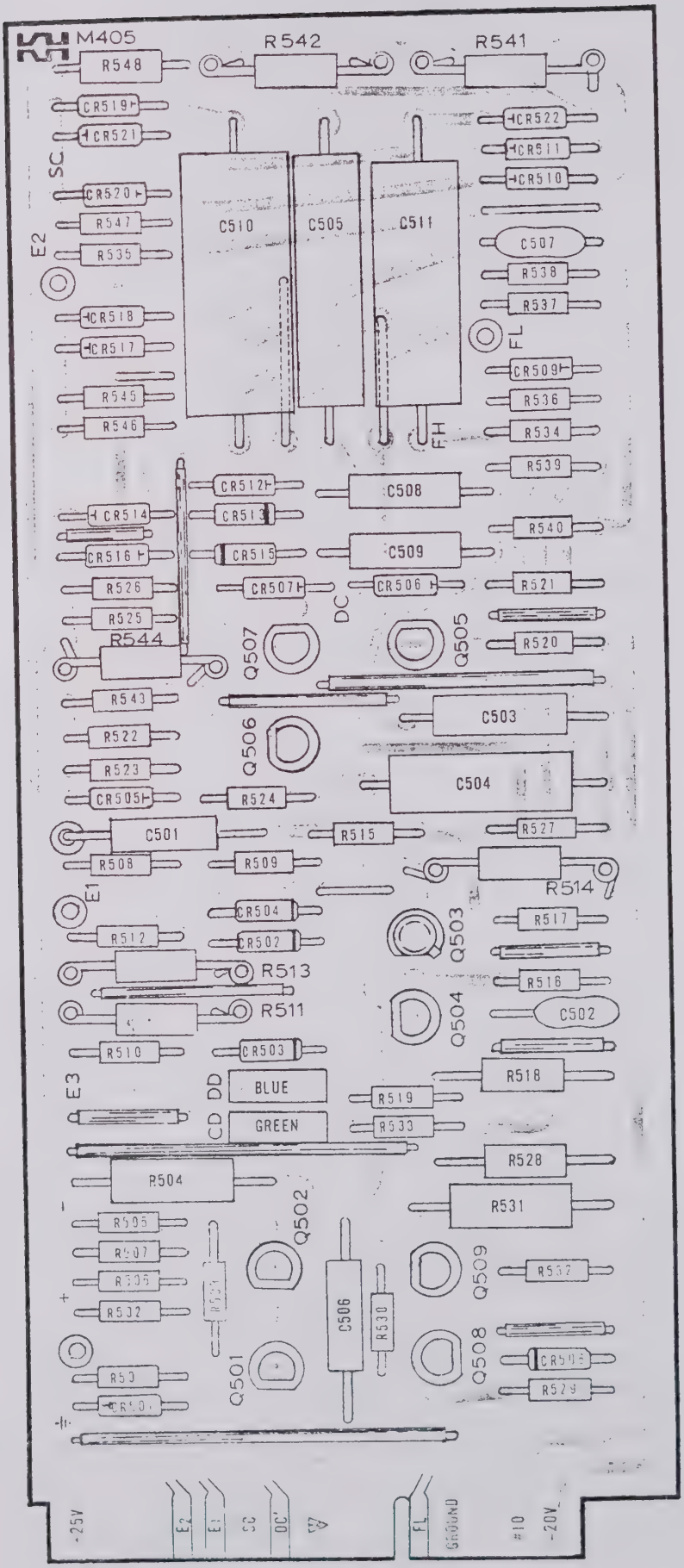
Symbol	Description	Mfr.	Part No.
CR503	SG5445	Trans	SG5445
CR504	SG5445	Trans	SG5445
CR505	1N456	Trans	1N456
CR506	1N456*	Trans	1N456*
CR507	1N456*	Trans	1N456*
CR508	SG5445	Trans	SG5445
CR509	1N456	Trans	1N456
CR510	1N456	Trans	1N456
CR511	1N456	Trans	1N456
CR512	1N456	Trans	1N456
CR513	SG5445	Trans	SG5445

Symbol	Description	Mfr.	Part No.
CR514	1N456*	Trans	1N456*
CR515	SG5445	Trans	SG5445
CR516	1N456*	Trans	1N456*
CR517	1N456	Trans	1N456
CR518	1N456	Trans	1N456
CR519	1N456*	Trans	1N456*
CR520	1N456*	Trans	1N456*
CR521	1N456*	Trans	1N456*
CR522	1N456	Trans	1N456

*Selected for 0.1 nanoampere leakage

MANUFACTURERS CODE

A-B	Allen-Bradley Co.	Milwaukee, Wis.	TRANS	Transitron Electric Corp.	Wakefield, Mass.
C-D	Cornell-Dubilier Elec.	Newark, N. J.	MOT	Motorola Semiconductor	Phoenix, Arizona
EL	Electro Motive Mfg. Inc.	Willimantic, Conn.	ELP	Elpac Inc.	Fullerton, California
TI	Texas Instruments, Inc.	Dallas, Texas			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R542
R541
R548
CR519
CR521
CR522
CR511
CR510
SC
CR520
R547
R535
E2
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C511
C507
R538
R537
CR518
CR517
FL
CR509
R536
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CR507
CR506
R521
DC
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R544
Q507
Q505
R520
R543
C503
Q506
R522
R523
C504
CR505
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R527
C501
R515
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R514
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CR504
R517
R512
CR502
Q503
R513
R516
R511
Q504
C502
R510
CR503
R518
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DD
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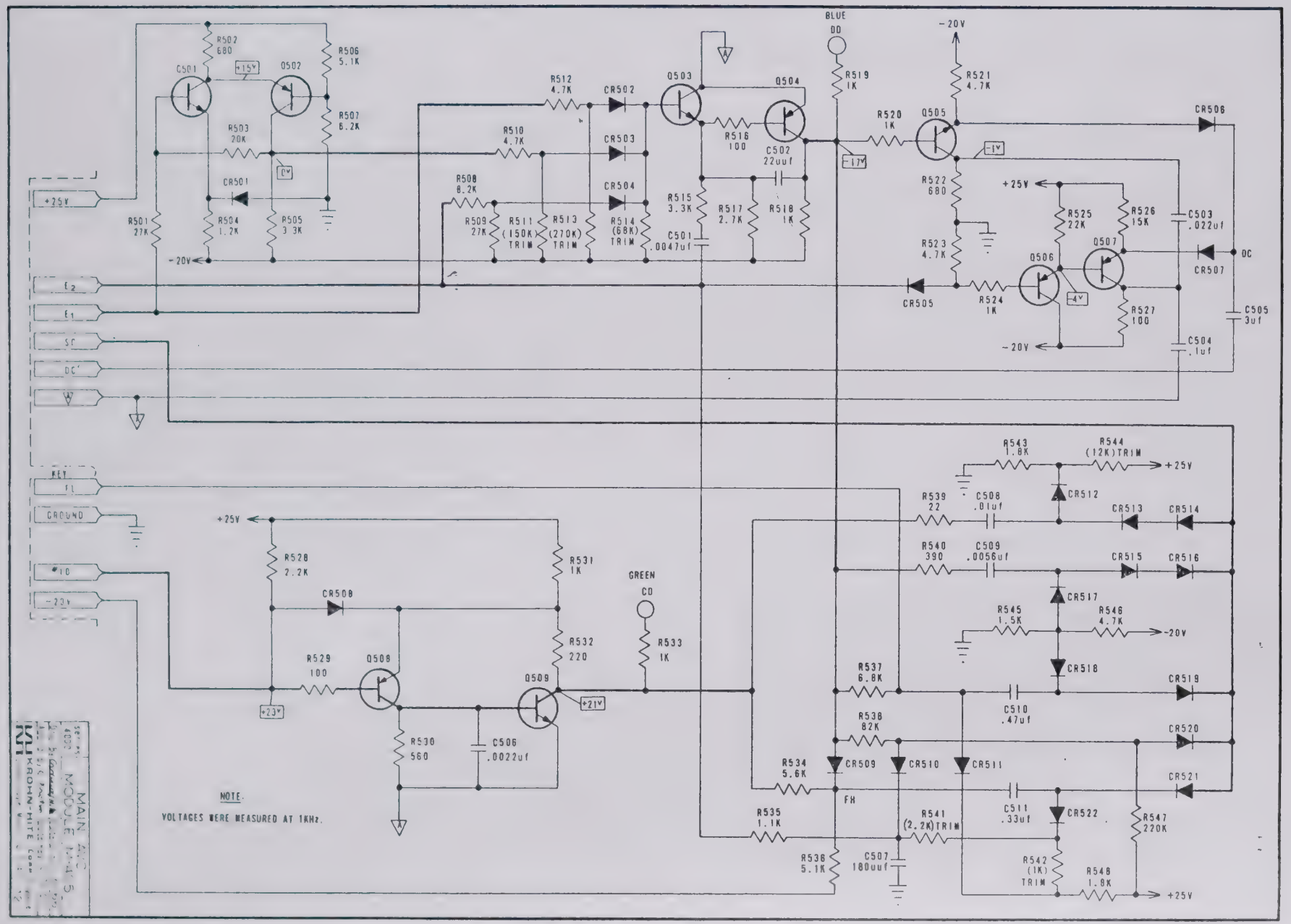
R519
CD
GREEN
R533
R528
R504
R531
Q502
R505
R507
Q509
R506
R532
C506
R530
Q501
Q508
R503
CR501
R529
-25V
E2
E1
SC
DC
FL
GROUND
#10
-20V


BLUE
DD
GREEN
CD
+25V
-20V
+15V
0V
-1V
-17V
+23V
+21V
-4V
FH
R501 27K
R502 680
R503 20K
R504 1.2K
R505 3.3K
R506 5.1K
R507 6.2K
R508 8.2K
R509 27K
R510 4.7K
R511 (150K) TRIM
R512 4.7K
R513 (270K) TRIM
R514 (68K) TRIM
R515 3.3K
R516 100
R517 2.7K
R518 1K
R519 1K
R520 1K
R521 4.7K
R522 680
R523 4.7K
R524 1K
R525 22K
R526 15K
R527 100
R528 2.2K
R529 100
R530 560
R531 1K
R532 220
R533 1K
R534 5.6K
R535 1.1K
R536 5.1K
R537 6.8K
R538 82K
R539 22
R540 390
R541 (2.2K) TRIM
R542 (1K) TRIM
R543 1.8K
R544 (12K) TRIM
R545 1.5K
R546 4.7K
R547 220K
R548 1.8K
C501 .0047uf
C502 22uuf
C503 .022uf
C504 .1uf
C505 3uf
C506 .0022uf
C507 180uuf
C508 .01uf
C509 .0056uf
C510 .47uf
C511 .33uf
Q501
Q502
Q503
Q504
Q505
Q506
Q507
Q508
Q509
CR501
CR502
CR503
CR504
CR505
CR506
CR507
CR508
CR509
CR510
CR511
CR512
CR513
CR514
CR515
CR516
CR517
CR518
CR519
CR520
CR521
CR522
E2
E1
SC
DC'
V
KEY
J1
GROUND
+10
-20V
DC
NOTE.
VOLTAGES WERE MEASURED AT 1KHz.
MAIN A/C MODULE M-14-5
KROHN-HITE

RESISTORS

Symbol	Description			Mfr.	Part No.
R601	649	1%	1W	IRC	AS-1
R602	Trim		1/2W	IRC	CEC-TO
R603	10K	1%	1/2W	IRC	CEC-TO
R604	10K	5%	1/4W	AB	CB-1035
R605	Trim		1/2W	IRC	CEC-TO
R606	10K	1%	1/2W	IRC	CEC-TO
R607	15K	5%	1/4W	AB	CB-1535
R608	1K	5%	1/4W	AB	CB-1025
R609	5.6K	10%	1/2W	AB	EB-5621
R610	237	1%	1/2W	IRC	CEC-TO
R611	43.2K	1%	1/2W	IRC	CEC-TO
R612	Trim		1W	IRC	AS-1
R613	93	1%	1W	IRC	AS-1
R614	130K	5%	1/4W	AB	CB-1345
R615	2.4K	1%	1W	IRC	AS-1
R616	1.78K	1%	1W	IRC	AS-1
R617	1.15K	1%	1W	IRC	AS-1
R618	1.5K	1%	1W	IRC	AS-1
R619	330K	1%	1/2W	IRC	CEC-TO
R620	43.2K	1%	1W	IRC	CEC-TO
R621	3.92K	1%	1/2W	IRC	CEC-TO
R622	27	10%	1/4W	AB	CB-2701
R623	3.09K	1%	1/2W	IRC	CEC-TO
R624	1.5K	1%	1/2W	IRC	CEC-TO
R625	1K	10%	1/4W	AB	CB-1021
R626	6.8K	5%	1/4W	AB	CB-6825
R627	68K	10%	1/4W	AB	CB-6831
R628	10K	5%	1/4W	AB	CB-1035
R629	1K	10%	1/4W	AB	CB-1021
R630	2.7K	1%	1W	IRC	AS-1
R631	Trim		1W	IRC	AS-1
R632	49	1%	1W	IRC	AS-1
R633	100	20%	1/4W	AB	CB-1012
R634	10K	10%	1/4W	AB	CB-1031

Symbol	Description			Mfr.	Part No.
R635	10K	10%	1/4W	AB	CB-1031
R636	15K	5%	1/4W	AB	CB-1535
R637	100K	5%	1/4W	AB	CB-1045
R638	5.6K	10%	1/2W	AB	EB-5621
R639	2.2K	10%	1/4W	AB	CB-2221
R640	1K	10%	1/4W	AB	CB-1021
R641	1K	10%	1/4W	AB	CB-1021
R642	15K	5%	1/4W	AB	CB-1535
R643	820K	10%	1/4W	AB	CB-8241
R644	330	5%	1/4W	AB	CB-3315
R645	220K	10%	1/2W	AB	EB-2241
R646	10K	5%	1/4W	AB	CB-1035
R647	2K	5%	1/2W	AB	EB-2025
R648	15K	5%	1/4W	AB	CB-1535
R649	7.5K	5%	1/4W	AB	CB-7525
R650	2K	5%	1/4W	AB	CB-2025
R651	15K	10%	1/4W	AB	CB-1531
R652	22K	10%	1/2W	AB	EB-2231
R653	2K	5%	1/4W	AB	CB-2025
R654	7.5K	5%	1/4W	AB	CB-7525
R655	5.6K	10%	1/4W	AB	CB-5621
R656	5.6K	10%	1/4W	AB	CB-5621
R657	75	5%	1/4W	AB	CB-7505
R658	16K	5%	1/4W	AB	CB-1635
R659	3.3K	10%	1/4W	AB	CB-3321
R660	10K	5%	1/4W	AB	CB-1035
R661	8.2K	5%	1/4W	AB	CB-8225
R662	4.3K	5%	1/4W	AB	CB-4325
R663	5.1K	5%	1/4W	AB	CB-5125
R664	220	10%	1W	AB	GB-2211
R665	820	10%	1W	AB	GB-8211
R666	32K	1%	1/4W	IRC	CEB-TO

CAPACITORS

Symbol	Description			Mfr.	Part No.
C601	2.5-11pf			ERIE	538-006N300 B2PO-90R
C602	(TRIM) 51pf	5%	500V	El	DM15C510J
C603	0.47mf	10%	100V	ELP	Z1X474K
C604	(TRIM) 51pf	5%	500V	El	DM15C510J
C605	10pf	10%	500V	El	DM15C100K
C606	0.0022mf	10%	100V	C-D	WMF1D22
C607	10pf	5%	500V	EL	DM15C100K

Symbol	Description			Mfr.	Part No.
C608	470pf	10%	500V	El	DM15C471K
C609	10pf	10%	500V	EL	DM15C100K
C610	22pf	10%	500V	El	DM15C220K
C611	100pf	10%	500V	El	DM15C101K
C612	100pf	10%	500V	El	DM15C101K
C613	220pf	10%	500V	El	DM15C221K
C614	1mf	20%	35V	SP	150D105X0035A2

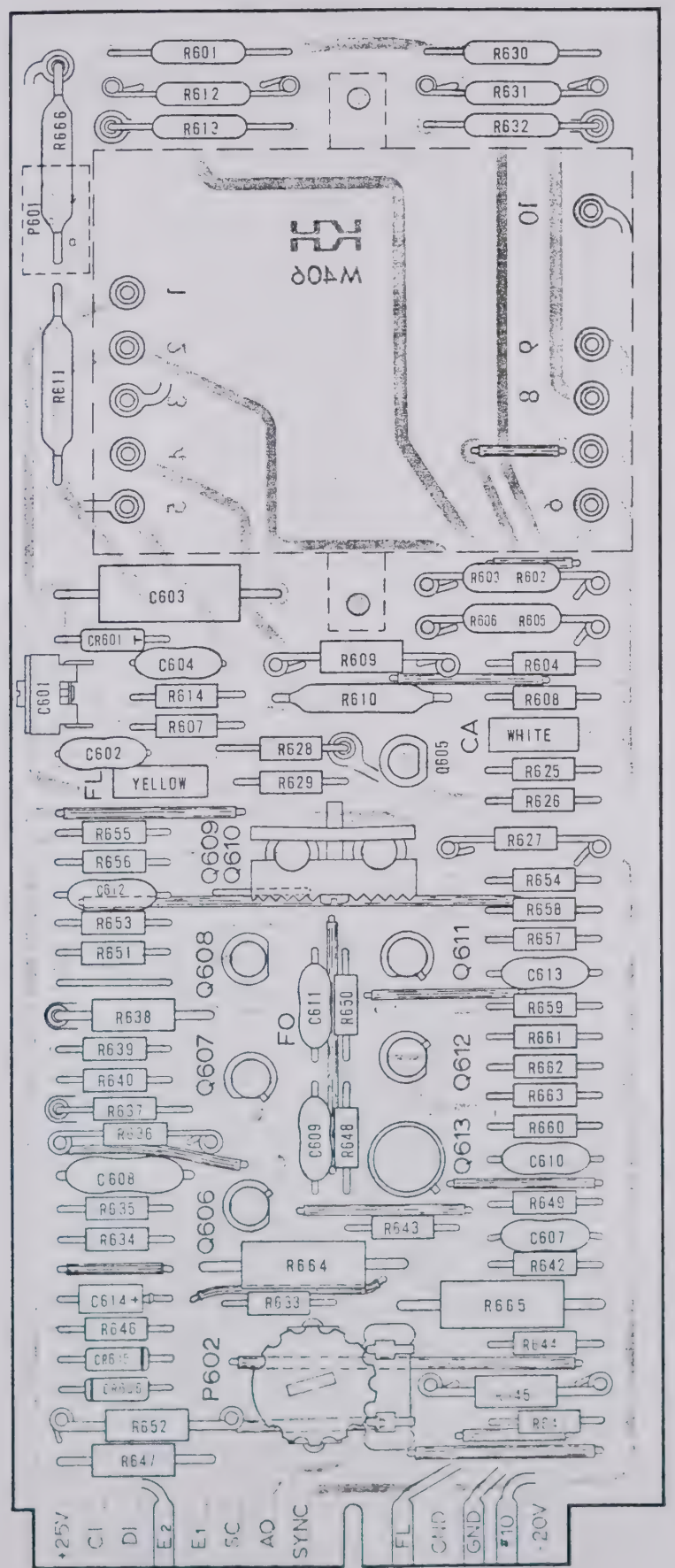
TRANSISTORS, DIODES, & MISC.

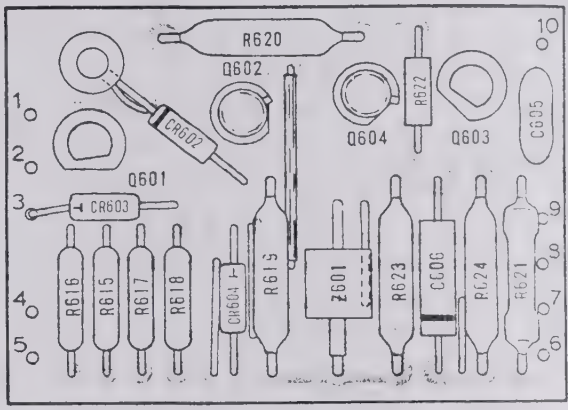
Symbol	Description	Mfr.	Part No.
Q601	2N3702	TI	2N3702
Q602	MM2000-2	Mot	MM2000-2
Q603	2N3711	TI	2N3711
Q604	MM2005-2	Mot	MM2005-2
Q605	2N3711	TI	2N3711
Q606	F1088A	UC	F1088A
Q607	MM2005-2	Mot	MM2005-2
Q608	2N3640	Fair	2N3640
Q609	2N3711	TI	2N3711
Q610	2N3711	TI	2N3711
Q611	MM2005-2	Mot	MM2005-2
Q612	MM2005-2	Mot	MM2005-2

Symbol	Description			Mfr.	Part No.
Q613	40315			RCA	40315
CR601	1N456			Trans	1N456
CR602	SG5445			Trans	SG5445
CR603	1N456			Trans	1N456
CR604	1N456			Trans	1N456
CR605	SG5445			Trans	SG5445
CR606	SG5445			Trans	SG5445
Z601	1N2163			SEM	1N2163
P601	5K	30%	1/4W	IRC	106-2
P602	25K	30%	1/4W	CTS	U201R253B

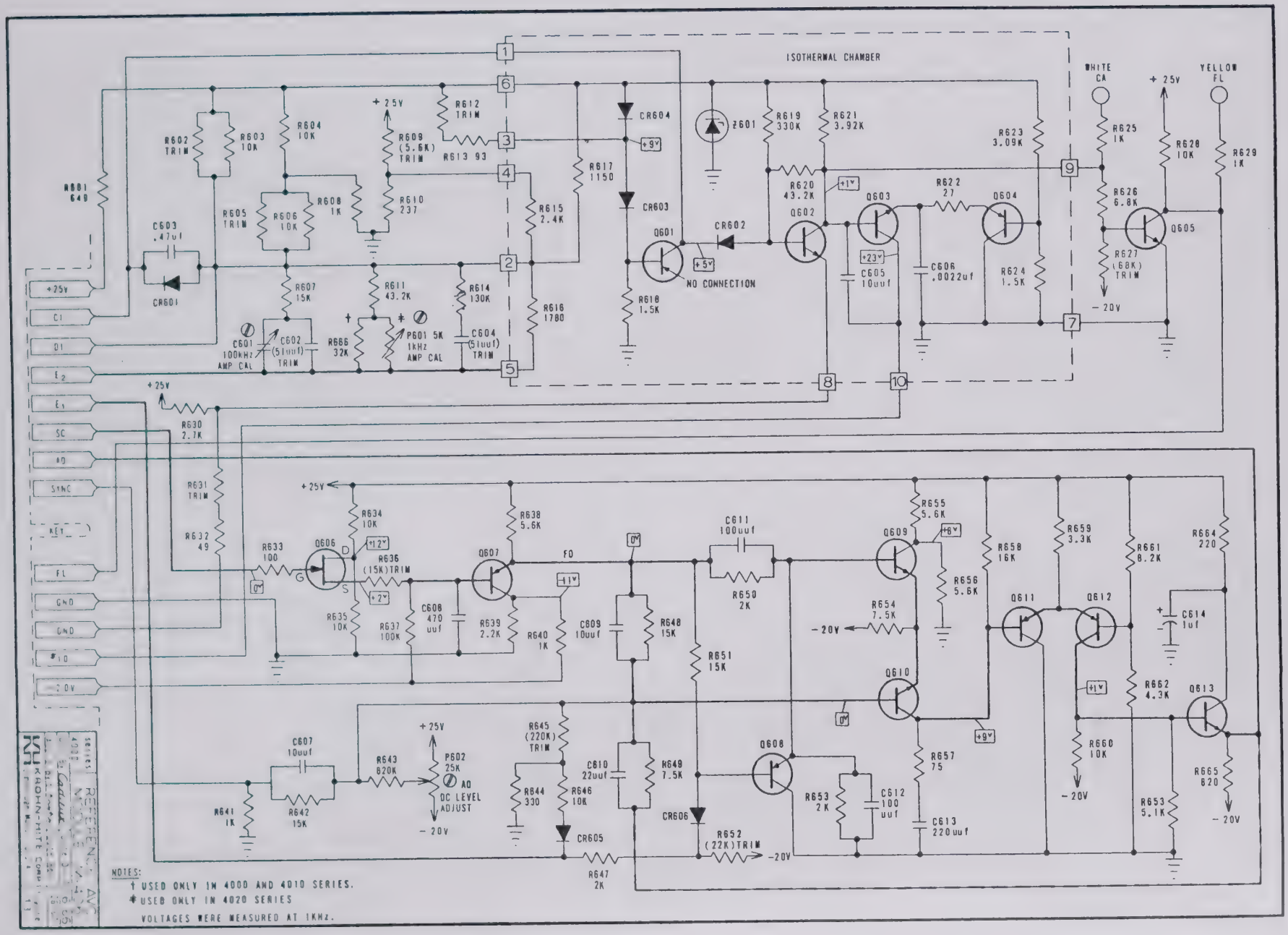
MANUFACTURERS CODE

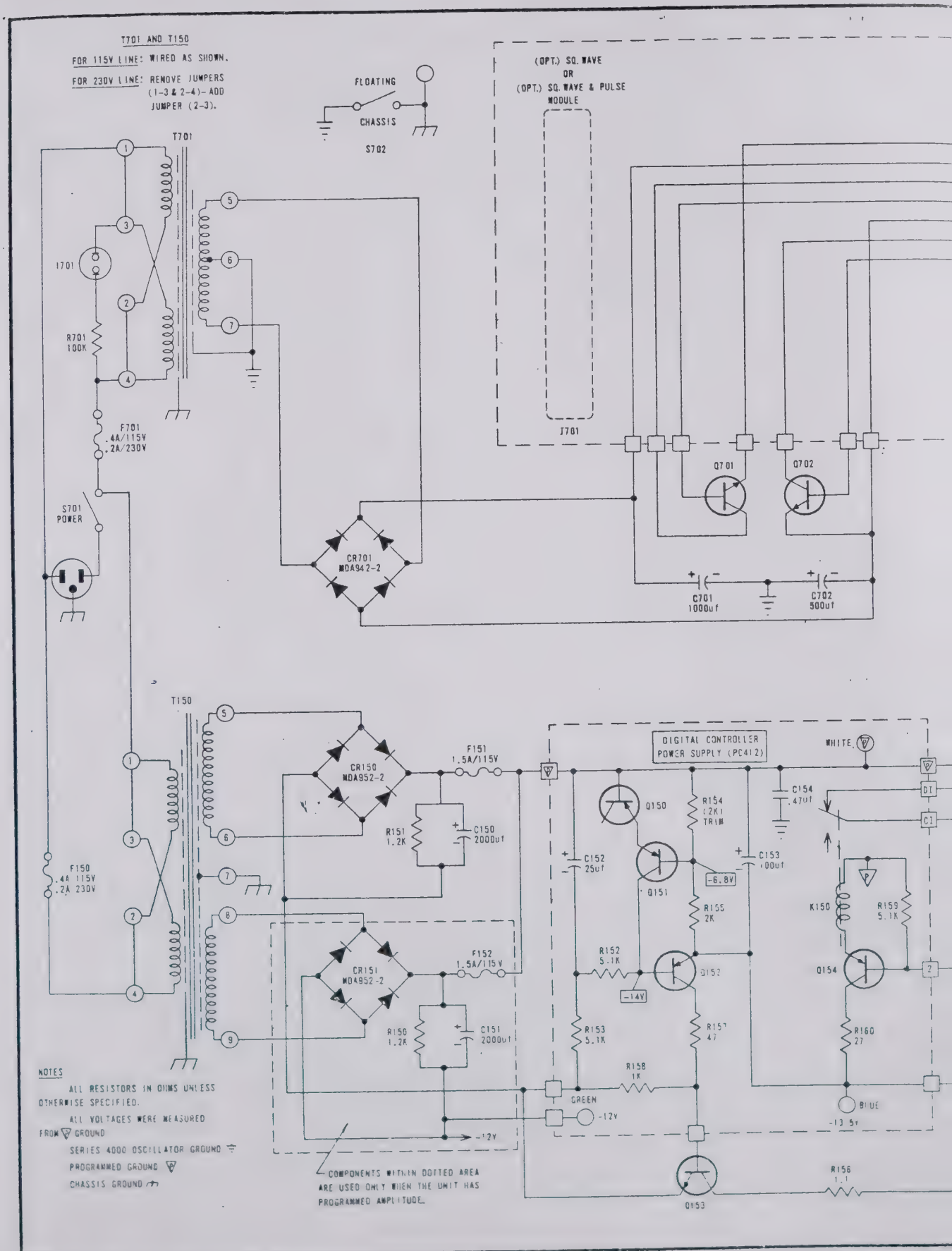
A-B	Allen-Bradley Co.	Milwaukee, Wis.
CTS	CTS Corp.	Elkhart, Ind.
EL	Electro Motive Mfg. Inc.	Willimantic, Conn.
FAIR	Fairchild Semiconductor	San Rafael, Calif.
IRC	International Resistance Co.	Philadelphia, Pa.
RCA	Radio Corporation of America	Harrison, N. J.
SEM	U. S. Semcor	Phoenix, Arizona
SP	Sprague Electric Co.	North Adams, Mass.
TI	Texas Instruments, Inc.	Dallas, Texas
TRANS	Transitron Electric Corp.	Wakefield, Mass.
MOT	Motorola Semiconductor	Phoenix, Arizona
UC	Union Carbide Electronics	Mountain View, Calif.
ELP	Elpac, Inc.	Fullerton, Calif.
ERIE	Erie Products Inc.	Erie, Pa.


R601
R612
R613
R630
R631
R632
R666
P601
W406
C603
CR601
C604
R614
R607
C602
YELLOW
C601
R611
R603
R602
R606
R605
R609
R610
R604
R608
WHITE
R628
R629
Q605
CA
R625
R626
FL
R655
R656
Q609
Q610
Q612
R653
R651
R627
R654
R658
R657
C613
R659
R661
R662
R663
R660
C610
R649
C607
R642
R638
R639
R640
R637
R636
C608
R635
R634
C614
R646
R652
R647
R664
R633
R643
R665
P602
Q608
Q607
Q606
Q611
Q613
FO
C611
R650
C609
R648
+25V
C1
D1
E2
E1
S.C
AO
SYNC
FL
GND
GND
+10
-20V

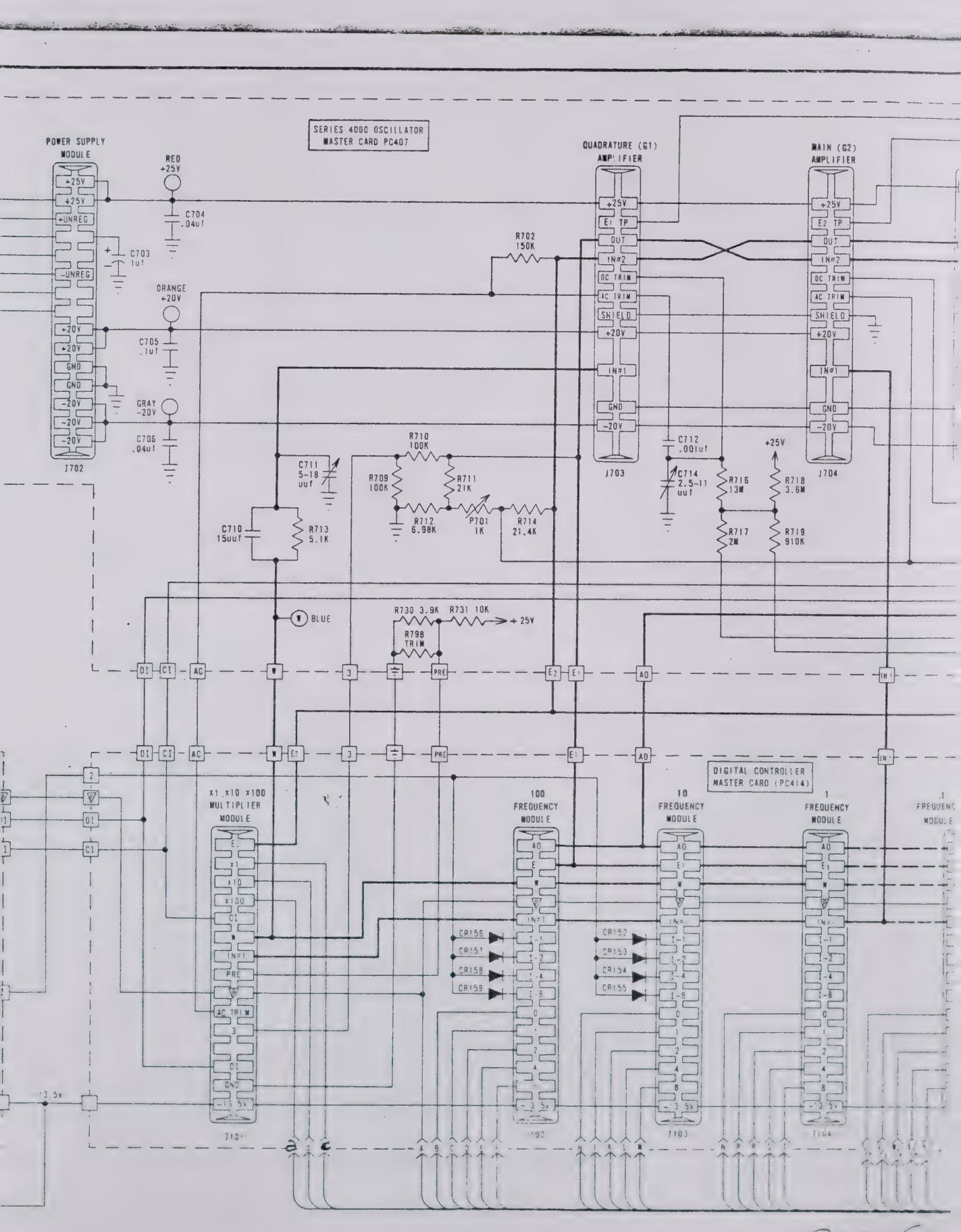

R620
Q602
CR602
Q604
R612
Q603
C605
Q601
CR603
R616
R615
R617
R618
CR604
R613
Z601
R623
C606
R624
R621

PC408

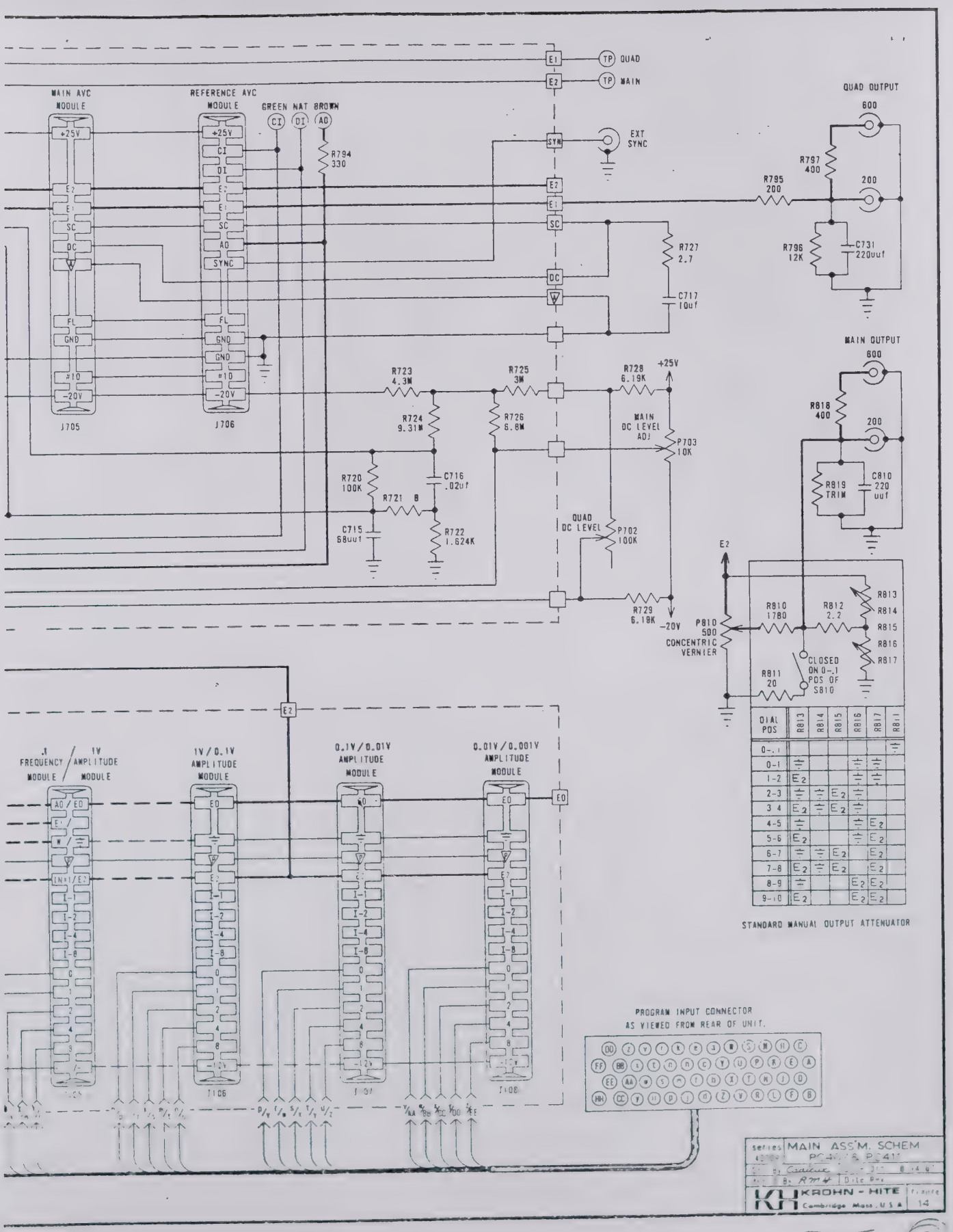

ISOTHERMAL CHAMBER
WHITE CA
YELLOW FL
+25V
R601 649
R602 TRIM
R603 10K
R604 10K
R605 TRIM
R606 10K
R607 15K
R608 1K
R609 (5.6K) TRIM
R610 237
R611 43.2K
R612 TRIM
R613 93
R614 130K
R615 2.4K
R616 1780
R617 1150
R618 1.5K
C601 100KHz AMP CAL
C602 (51uuf) TRIM
C603 .47uf
C604 (51uuf) TRIM
CR601
R606 32K
P601 5K 1kHz AMP CAL
CR603
CR604
CR602
Z601
Q601
Q602
Q603
Q604
Q605
+9V
+5V
+1V
+23V
NO CONNECTION
R619 330K
R620 43.2K
R621 3.92K
R622 27
R623 3.09K
C605 10uuf
C606 .0022uf
R624 1.5K
R625 1K
R626 6.8K
R627 (68K) TRIM
R628 10K
R629 1K
- 20V
1
2
3
4
5
6
7
8
9
10
+25V
C1
D1
E2
E1
SC
AO
SYNC
KEY
FL
GND
GND
+10
-20V
R630 2.7K
R631 TRIM
R632 49
R633 100
Q606
R634 10K
R635 10K
R636 (15K) TRIM
R637 100K
C608 470 uuf
Q607
R638 5.6K
R639 2.2K
R640 1K
C609 10uuf
R648 15K
FO
C611 100uuf
R650 2K
R651 15K
Q609
R655 5.6K
R656 5.6K
R654 7.5K
Q610
R657 75
R658 16K
R659 3.3K
R661 8.2K
R664 220
Q611
Q612
Q613
C614 1uf
R662 4.3K
R660 10K
R665 820
R653 5.1K
C607 10uuf
R641 1K
R642 15K
R643 820K
P602 25K AO DC LEVEL ADJUST
R645 (220K) TRIM
R644 330
R646 10K
C610 22uuf
R649 7.5K
Q608
R653 2K
C612 100 uuf
C613 220uuf
CR605
CR606
R652 (22K) TRIM
R647 2K
NOTES:
† USED ONLY IN 4000 AND 4010 SERIES.
* USED ONLY IN 4020 SERIES
VOLTAGES WERE MEASURED AT 1KHz.
KH KROHN-HITE Corp.


T701 AND T150
FOR 115V LINE: WIRED AS SHOWN.
FOR 230V LINE: REMOVE JUMPERS (1-3 & 2-4)- ADD JUMPER (2-3).
FLOATING
CHASSIS
S702
(OPT.) SQ. WAVE
OR
(OPT.) SQ. WAVE & PULSE
MODULE
J701
T701
I701
R701
100K
F701
.4A/115V
.2A/230V
S701
POWER
CR701
MDA942-2
Q701
Q702
C701
1000uf
C702
500uf
T150
F150
.4A 115V
.2A 230V
CR150
MDA952-2
F151
1.5A/115V
R151
1.2K
C150
2000uf
CR151
MDA952-2
F152
1.5A/115V
R150
1.2K
C151
2000uf
DIGITAL CONTROLLER
POWER SUPPLY (PC412)
WHITE
Q150
R154
(2K)
TRIM
C154
.47uf
C152
25uf
Q151
C153
100uf
-6.8V
R155
2K
R152
5.1K
-14V
Q152
R153
5.1K
R157
47
R158
1K
GREEN
-12V
-12V
K150
R159
5.1K
Q154
R160
27
BLUE
-13.5V
Q153
R156
1.1
COMPONENTS WITHIN DOTTED AREA ARE USED ONLY WHEN THE UNIT HAS PROGRAMMED AMPLITUDE.
NOTES
ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED.
ALL VOLTAGES WERE MEASURED FROM ▽ GROUND
SERIES 4000 OSCILLATOR GROUND ⏚
PROGRAMMED GROUND ▽
CHASSIS GROUND

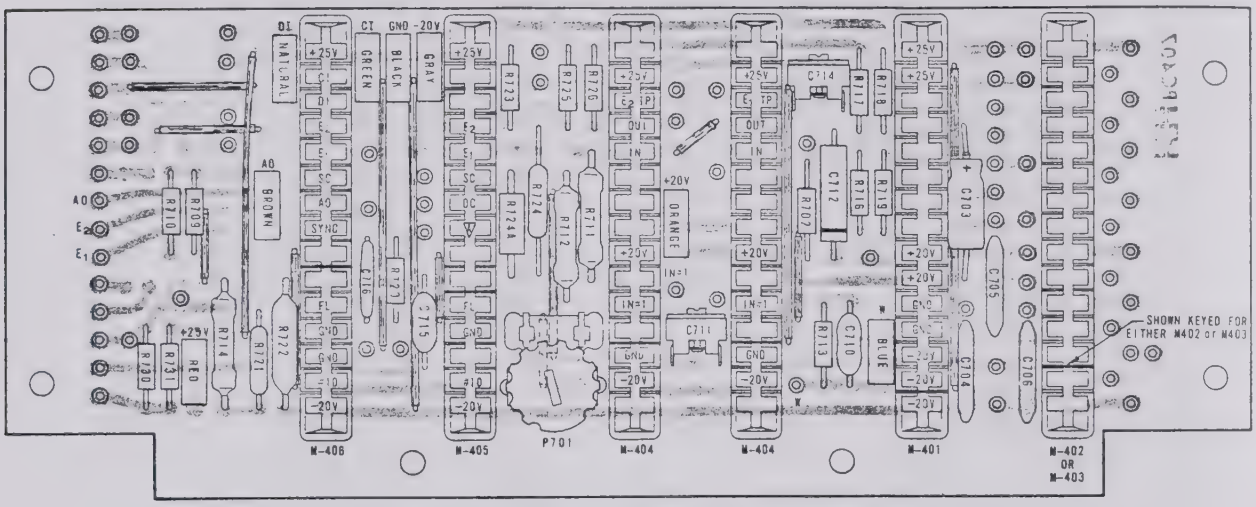
PART 6


SERIES 4000 OSCILLATOR
MASTER CARD PC407
POWER SUPPLY MODULE
J702
+25V
+UNREG
-UNREG
+20V
GND
-20V
RED +25V
C704 .04uf
C703 1uf
ORANGE +20V
C705 .1uf
GRAY -20V
C706 .04uf
QUADRATURE (G1) AMPLIFIER
J703
+25V
E1 TP
OUT
IN#2
DC TRIM
AC TRIM
SHIELD
+20V
IN#1
GND
-20V
MAIN (G2) AMPLIFIER
J704
E2 TP
R702 150K
C711 5-18 uuf
R710 100K
R709 100K
R711 21K
R712 6.98K
P701 1K
R714 21.4K
C710 15uuf
R713 5.1K
C712 .001uf
C714 2.5-11 uuf
R715 13M
R716 2M
R718 3.6M
R719 910K
BLUE
R730 3.9K
R731 10K
R798 TRIM
DI
CI
AC
W
PRE
E2
E1
AO
IN1
DIGITAL CONTROLLER MASTER CARD (PC414)
x1 x10 x100 MULTIPLIER MODULE
100 FREQUENCY MODULE
10 FREQUENCY MODULE
1 FREQUENCY MODULE
.1 FREQUENCY MODULE
CR156
CR157
CR158
CR159
CR152
CR153
CR154
CR155
AC TRIM
+3.5V
J100
J102
J103
J104

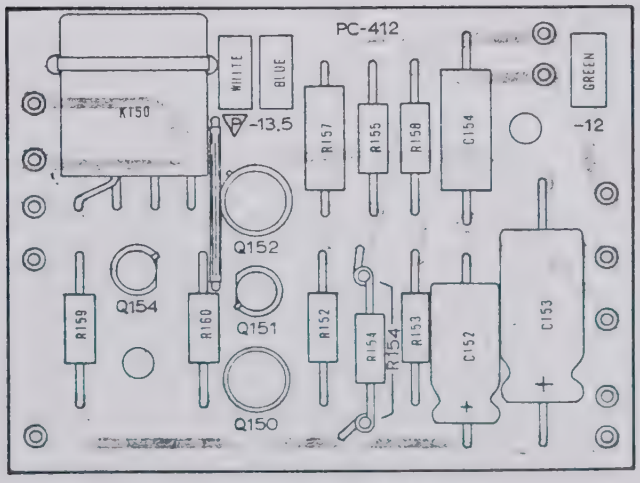
PART 5


MAIN AVC MODULE
REFERENCE AVC MODULE
GREEN
NAT
BROWN
J705
J706
R794 330
EXT SYNC
QUAD OUTPUT
600
200
R795 200
R796 12K
R797 400
C731 220uuf
R727 2.7
C717 10uf
MAIN OUTPUT
R818 400
R819 TRIM
C810 220 uuf
R723 4.3M
R724 9.31M
R725 3M
R726 6.8M
R728 6.19K
+25V
MAIN DC LEVEL ADJ
P703 10K
R720 100K
C716 .02uf
R721 8
C715 68uuf
R722 1.624K
QUAD DC LEVEL
P702 100K
R729 6.18K
-20V
P810 500 CONCENTRIC VERNIER
R810 1780
R812 2.2
R813
R814
R815
R816
R817
CLOSED ON 0-.1 POS OF S810
R811 20
DIAL POS
0-.1
0-1
1-2
2-3
3-4
4-5
5-6
6-7
7-8
8-9
9-10
STANDARD MANUAL OUTPUT ATTENUATOR
.1 FREQUENCY / 1V AMPLITUDE MODULE
1V AMPLITUDE MODULE
0.1V/0.01V AMPLITUDE MODULE
0.01V/0.001V AMPLITUDE MODULE
J705
J706
J707
J708
PROGRAM INPUT CONNECTOR
AS VIEWED FROM REAR OF UNIT.
series MAIN ASS'M. SCHEM
PC 40 & PC 41
KROHN-HITE
Cambridge Mass. U.S.A.
figure 14

PART 3



4000 SERIES OSCILLATOR MASTER CARD (PC-407)



DIGITAL CONTROLLER
POWER SUPPLY CARD (PC-412)

SERIES 4000 OSCILLATOR

RESISTORS

Symbol	Description			Mfr.	Part No.
R701	100K	10%	1/4W	AB	CB1041
R702	200K	5%	1/4W	AB	CB2045
R709	100K	5%	1/4W	AB	CB1045
R710	100K	5%	1/4W	AB	CB1045
R711	21K	1%	1/2W	IR	CEC-TO
R711*	21K	0.05%	3/10W	VI	S102
R712	6.98K	1%	1/2W	IR	CEC-TO
R712*	6.98K	0.05%	3/10W	VI	S102
R713	5.1K	5%	1/4W	AB	CB5125
R714	20.4K	1%	1/2W	IR	CEC-TO
R714*	20.4K	0.05%	3/10W	VI	S102
R716	13M	5%	1/4W	AB	CB1365
R717	2M	5%	1/4W	AB	CB2055
R718	3.6M	5%	1/4W	AB	CB3655
R719	910K	5%	1/4W	AB	CB9145
R720	100K	5%	1/4W	AB	CB1045
R721	8	1%	1W	IR	AS1
R722	1.624K	1%	1/2W	IR	CEC-TO
R722*	1,623.6	0.05%	3/10W	VI	S102
R723	4.3M	5%	1/4W	AB	CB4355
R724	9.31M	1%	1/2W	IR	CEC-TX
R725	3M	5%	1/4W	AB	CB3055

Symbol	Description			Mfr.	
R726	6.8M	5%	1/4W	AB	CB6855
R727	2.7	5%	1/2W	AB	EB27G5
R728	6.19K	1%	1/2W	IR	CEC-TO
R729	6.19K	1%	1/2W	IR	CEC-TO
R730	3.9K	5%	1/4W	AB	CB3925
R731	10K	5%	1/4W	AB	CB1035
R794	330	10%	1/4W	AB	CB3111
R795	200	1%	1W	IR	AS1
R796	12K	5%	1/4W	AB	CB1235
R797	400	1%	1W	IR	AS1
R810	1.78K	1%	1W	IR	AS1
R811	20	1%	1W	IR	AS1
R812	2.2	5%	1/2W	AB	EB22G5
R813	2K	1%	1W	IR	AS1
R814	1K	1%	1W	IR	AS1
R815	1K	1%	1W	IR	AS1
R816	500	1%	1W	IR	AS1
R817	500	1%	1W	IR	AS1
R818	400	1%	1W	IR	AS1
R819	Trim			AB	Type EB
R840	400	1%	1W	IR	AS1

* Used in Model 4031R

CAPACITORS

Symbol	Description			Mfr.	Part No.
C701	1000mf	+100% -10%	50V	SP	62D
C702	500mf	+100% -10%	50V	SP	62D
C703	1mf	+75% -10%	50V	SP	30D105G050BA2
C704	0.04mf	20%	500V	SP	5GA-S40
C705	0.1mf	20%	50V	SP	33C41A3
C706	0.04mf	20%	500V	SP	5GA-S40
C710	15mmf	5%	500V	EL	DM15C150J
C711	5-18mmf			ER	538-006NPO(COPO) 5.5-18pf(92R)

Symbol	Description			Mfr.	Part No.
C712	0.001mf	10%	100V	CD	WMF1D1G
C714	2.5-11mmf			ER	538-006N300(B2PO) 2.5-11pf(90R)
C715	68mmf	5%	500V	EL	DM15C680J
C716	0.02mf	20%	500V	SP	Z9C369A3
C717	10mf	10%	50V	KH	B2266B
C718	10mf		50V	KH	B2266B
C724	10mf		50V	KH	B2266B
C731	220mmf	5%	500V	EL	DM15C221J
C810	220mmf	10%	500V	EL	DM15C221K
C811	220mmf	10%	500V	EL	DM15C221K

TRANSISTORS, DIODES, & MISC.

Symbol	Description			Part No.	
Q701	2N3055			RC	2N3055
Q702	2N3055			RC	2N3055
CR701	Rectifier			MO	MDA942-2
F701	Fuse (115V)			BU	MDL .4A
F701	Fuse (230V)			BU	MDL .2A
I701	Pilot Light			ED	EG03-CCBNE2
P701	1K	30%	1/4W	CT	U201

Symbol	Description			Mfr.	Part No.
P702	10K	20%	2W	AB	JAIL040S103MC
P703	100K	20%	2W	AB	JAIL040S104RC
S701	Power Switch			CH	8280K27H
S702	Slide Switch			CW	G123
S810 } P810 }	Switch and Potentiometer Assy.			KH	B2269D
T701	Transformer			KH	P100-87B

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	MO	Motorola Semiconductor	Phoenix, Ariz.
BR	Branson Corp.	Denville, N. J.	RC	Radio Corp. of Am.	Harrison, N. J.
BU	Bussmann Mfg. Div.	St. Louis, Mo.	SP	Sprague Elec. Co.	N. Adams, Mass.
FR	Fairchild Semiconductor	San Rafael, Calif.	TR	Transitron Electric Corp.	Wakefield, Mass.
KH	Krohn-Hite Corp.	Cambridge, Mass.	WL	Ward Leonard Electric Co.	Mt. Vernon, N. Y.

DIGITAL CONTROLLER

RESISTORS

Symbol	Description			Mfr.	Part No.
R150	1.2K	10%	2W	AB	HB1221
R151	1.2K	10%	2W	AB	HB1221
R152	5.1K	5%	1/2W	AB	EB5125
R153	5.1K	5%	1/2W	AB	EB5125
R154	Trim			AB	TYPE EB
R155	2K	5%	1/2W	AB	EB2025

Symbol	Description			Mfr.	Part No.
R156	1.1	5%	5W	WL	5X
R157	47	10%	1W	AB	GB4701
R158	1K	10%	1/2W	AB	EB1021
R159	5.1K	5%	1/2W	AB	EB5125
R160	27	5%	1/2W	AB	EB2705

CAPACITORS

Symbol	Description			Mfr.	Part No.
C150	2000mf	+75% -10%	30V	SP	D45349
C151	2000mf	+75% -10%	30V	SP	D45349
C152	25mf	+100% -10%	25V	SP	30D256G025CB4

Symbol	Description			Mfr.	Part No.
C153	100mf	+100% -10%		SP	30D107G025DD4
C154	.47mf	20%	100V	EP	Z1X474K

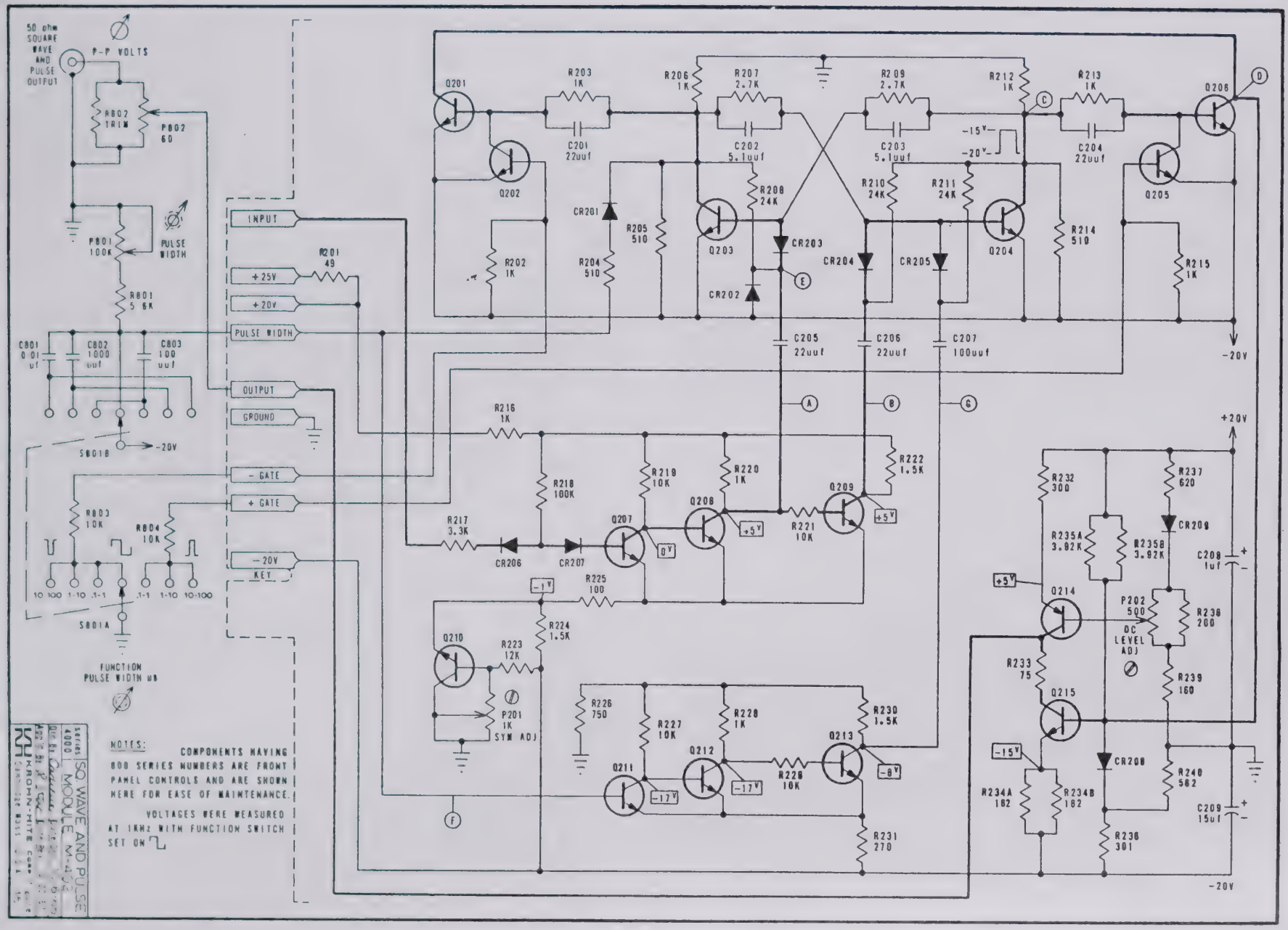
TRANSISTORS, DIODES, & MISC.

Symbol	Description	Mfr.	Part No.
Q150	2N3638	FR	2N3638
Q151	2N3136	MO	2N3136
Q152	40319	RC	40319
Q154	2N3136	MO	2N3136
CR150	Rectifier	MO	MDA-952-2
CR151	Rectifier	MO	MDA-952-2
CR152	1N456	TR	1N456
CR153	1N456	TR	1N456
CR154	1N456	TR	1N456
CR155	1N456	TR	1N456

Symbol	Description	Mfr.	Part No.
CR156	1N456	TR	1N456
CR157	1N456	TR	1N456
CR158	1N456	TR	1N456
CR159	1N456	TR	1N456
F150	Fuse (115V)	BU	MDL .4A
F150	Fuse (230V)	BU	MDL .2A
F151	Fuse	BU	MDX 1.5A
F152	Fuse	BU	MDX 1.5A
T150	Transformer	KH	P100-90
K150	Relay	BR	AR6650

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	MO	Motorola Semiconductor	Phoenix, Arizona
BR	Branson Corp.	Denville, N. J.	RC	Radio Corp. of America	Harrison, N. J.
BU	Bussmann Mfg. Div.	St. Louis, Mo.	SP	Sprague Electric Co.	North Adams, Mass.
EP	Elpac, Inc.	Fullerton, Calif.	TR	Transitron Electric Corp.	Wakefield, Mass.
FR	Fairchild Semiconductor	San Rafael, Calif.	WL	Ward Leonard Electric Co.	Mt. Vernon, N. Y.
KH	Krohn-Hite Corp.	Cambridge, Mass.			

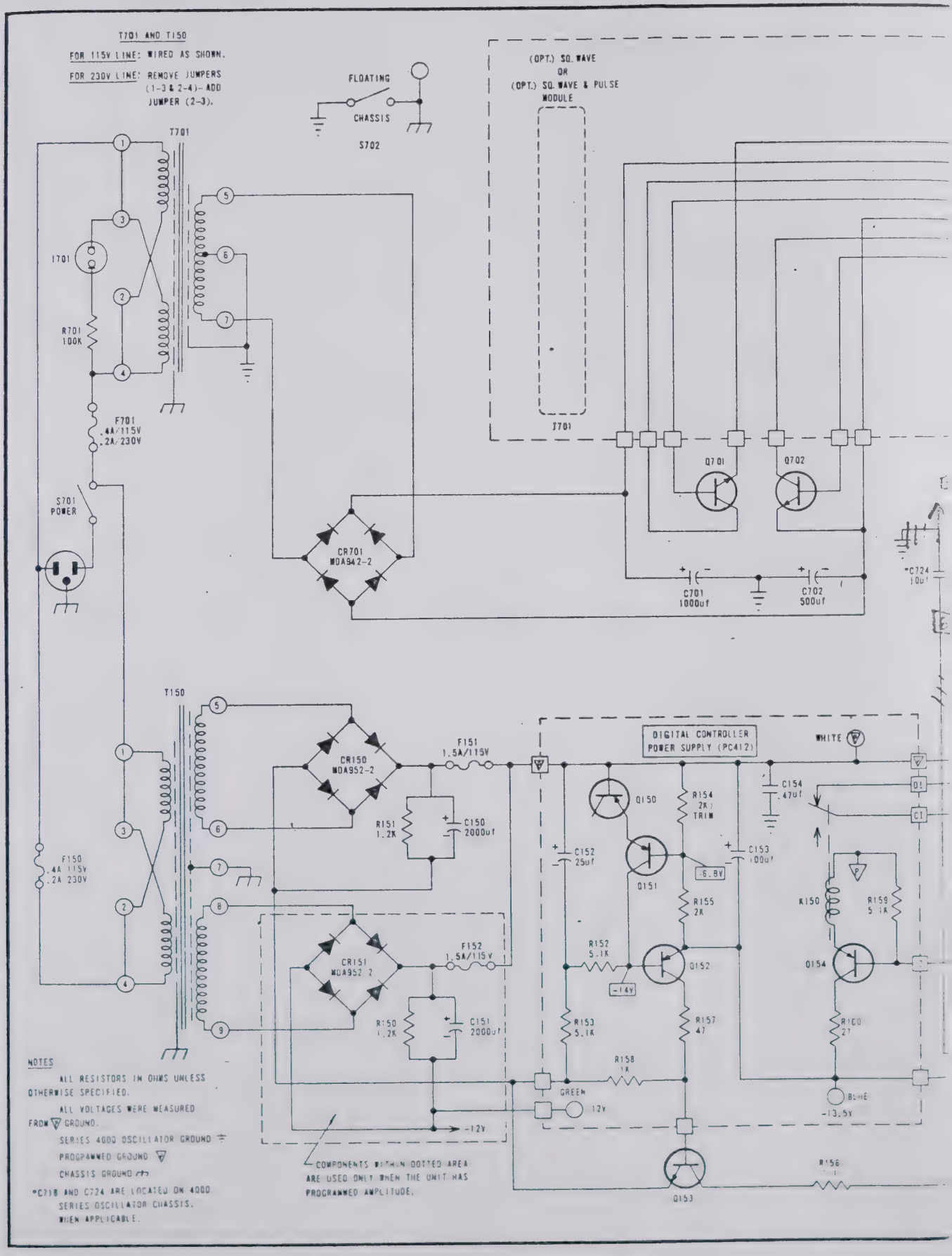


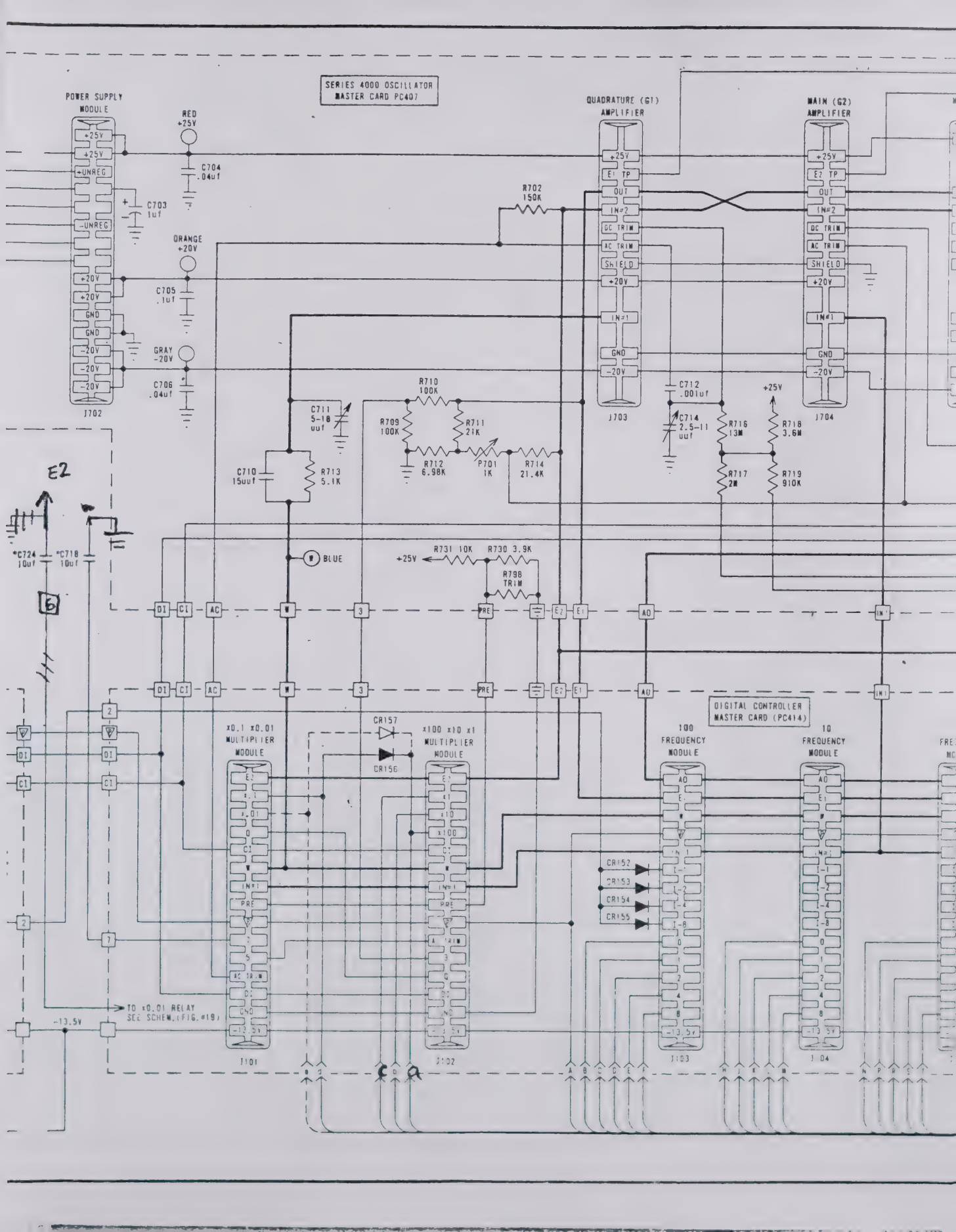
NOTES: COMPONENTS HAVING 800 SERIES NUMBERS ARE FRONT PANEL CONTROLS AND ARE SHOWN HERE FOR EASE OF MAINTENANCE.

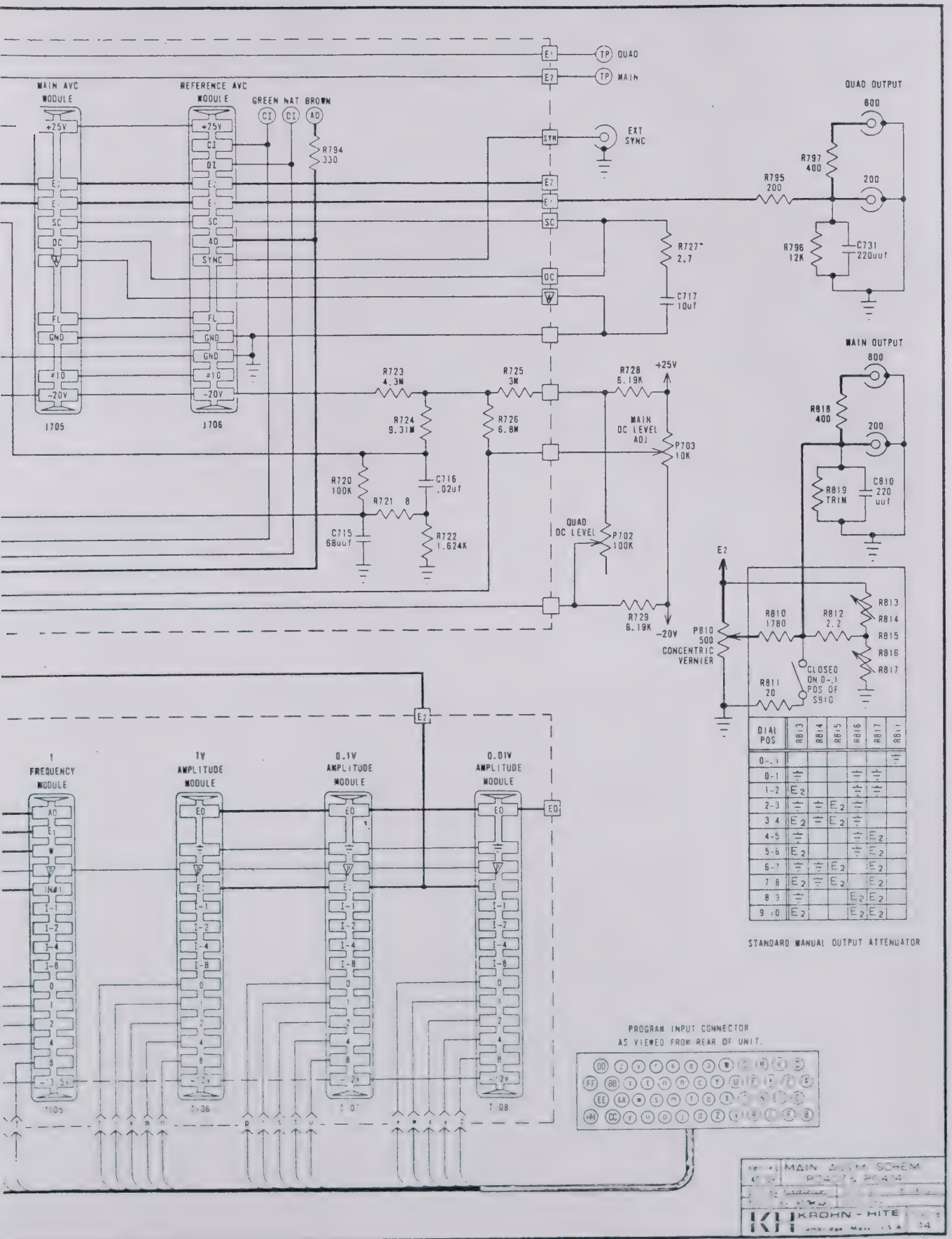
VOLTAGES WERE MEASURED AT 1KHz WITH FUNCTION SWITCH SET ON

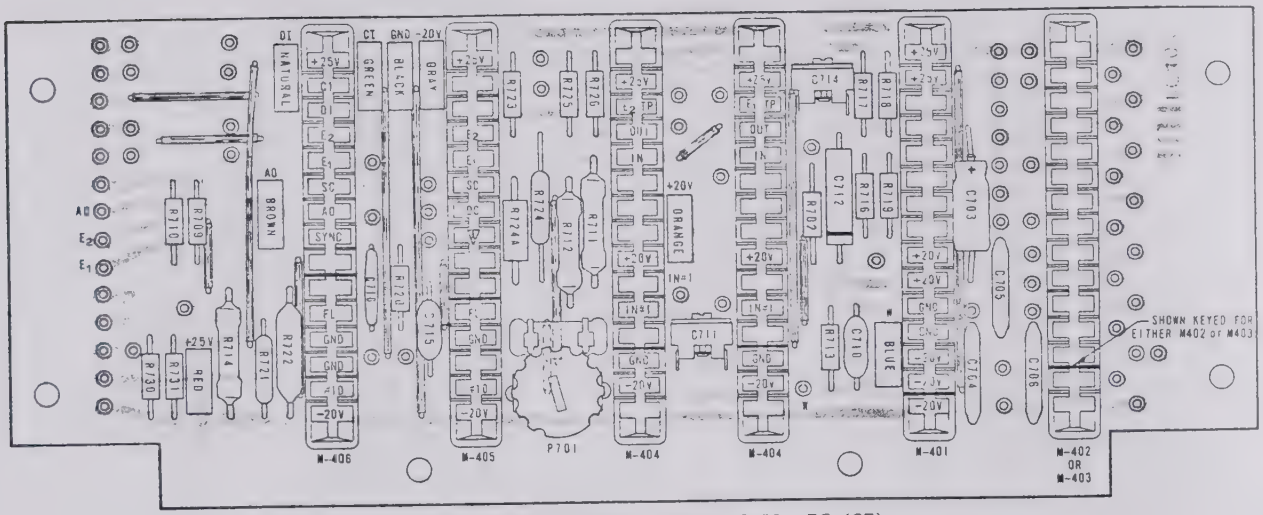
KROHN-HITE

Series 4000 | SQ. WAVE AND PULSE MODULE M-492

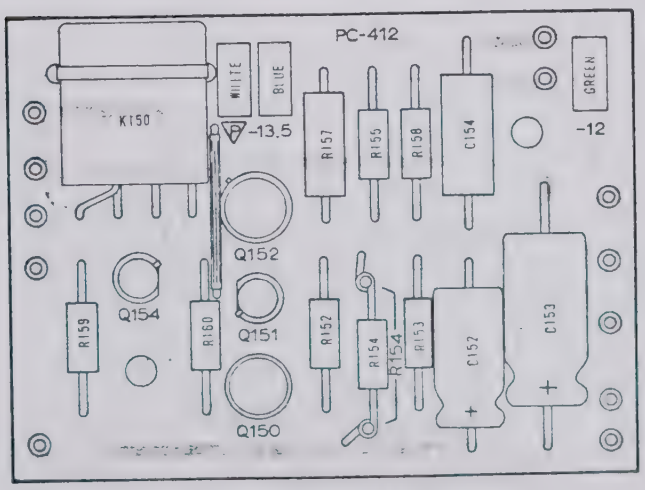

T701 AND T150
FOR 115V LINE: WIRED AS SHOWN.
FOR 230V LINE: REMOVE JUMPERS (1-3 & 2-4)- ADD JUMPER (2-3).
FLOATING
CHASSIS
S702
(OPT.) SQ. WAVE OR (OPT.) SQ. WAVE & PULSE MODULE
J701
T701
I701
R701 100K
F701 .4A/115V .2A/230V
S701 POWER
CR701 MDA942-2
Q701
Q702
C701 1000uf
C702 500uf
*C724 10uf
T150
F150 .4A 115V .2A 230V
CR150 MDA952-2
F151 1.5A/115V
R151 1.2K
C150 2000uf
CR151 MDA952-2
F152 1.5A/115V
R150 1.2K
C151 2000uf
DIGITAL CONTROLLER POWER SUPPLY (PC412)
WHITE
Q150
Q151
Q152
Q153
Q154
R154 2K TRIM
R155 2K
R152 5.1K
R153 5.1K
R157 47
R158 1K
R159 5.1K
R160 27
R156
C152 25uf
C153 100uf
C154 .47uf
K150
-6.8V
-14V
GREEN
+12V
BLUE
-13.5V
-12V
NOTES
ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED.
ALL VOLTAGES WERE MEASURED FROM ▽ GROUND.
SERIES 4000 OSCILLATOR GROUND ⏚
PROGRAMMED GROUND ▽
CHASSIS GROUND
*C718 AND C724 ARE LOCATED ON 4000 SERIES OSCILLATOR CHASSIS, WHEN APPLICABLE.
COMPONENTS WITHIN DOTTED AREA ARE USED ONLY WHEN THE UNIT HAS PROGRAMMED AMPLITUDE.


SERIES 4000 OSCILLATOR
MASTER CARD PC407
POWER SUPPLY
MODULE
+25V
+25V
+UNREG
-UNREG
+20V
+20V
GND
GND
-20V
-20V
-20V
J702
RED
+25V
C704
.04uf
C703
1uf
ORANGE
+20V
C705
.1uf
GRAY
-20V
C706
.04uf
QUADRATURE (G1)
AMPLIFIER
+25V
E1 TP
OUT
IN#2
DC TRIM
AC TRIM
SHIELD
+20V
IN#1
GND
-20V
J703
MAIN (G2)
AMPLIFIER
+25V
E2 TP
OUT
IN#2
DC TRIM
AC TRIM
SHIELD
+20V
IN#1
GND
-20V
J704
R702
150K
R710
100K
R709
100K
R711
21K
R712
6.98K
P701
1K
R714
21.4K
C711
5-18
uuf
C710
150uuf
R713
5.1K
C712
.001uf
C714
2.5-11
uuf
R716
13M
R717
2M
+25V
R718
3.6M
R719
910K
E2
*C724
10uf
*C718
10uf
BLUE
+25V
R731 10K
R730 3.9K
R798
TRIM
D1
C1
AC
W
3
PRE
E2
E1
AO
IN1
DIGITAL CONTROLLER
MASTER CARD (PC414)
x0.1 x0.01
MULTIPLIER
MODULE
CR157
CR156
x100 x10 x1
MULTIPLIER
MODULE
100
FREQUENCY
MODULE
10
FREQUENCY
MODULE
CR152
CR153
CR154
CR155
TO x0.01 RELAY
SEE SCHEM. (FIG. #19)
-13.5V
J101
J102
J103
J104


MAIN AVC MODULE
REFERENCE AVC MODULE
GREEN WHT BROWN
J705
J706
QUAD
MAIN
EXT SYNC
QUAD OUTPUT
MAIN OUTPUT
R794 330
R795 200
R796 12K
R797 400
C731 220uuf
R727 2.7
C717 10uf
R723 4.3M
R724 9.31M
R725 3M
R726 6.8M
R728 6.19K
R729 6.19K
+25V
-20V
MAIN DC LEVEL ADJ
P703 10K
QUAD DC LEVEL
P702 100K
R720 100K
R721 8
C716 .02uf
C715 68uuf
R722 1.624K
R818 400
R819 TRIM
C810 220 uuf
P810 500 CONCENTRIC VERNIER
R810 1780
R811 20
R812 2.2
R813
R814
R815
R816
R817
CLOSED ON 0-.1 POS OF SB10
DIAL POS
R813
R814
R815
R816
R817
R811
1 FREQUENCY MODULE
1V AMPLITUDE MODULE
0.1V AMPLITUDE MODULE
0.01V AMPLITUDE MODULE
STANDARD MANUAL OUTPUT ATTENUATOR
PROGRAM INPUT CONNECTOR
AS VIEWED FROM REAR OF UNIT.
KROHN-HITE



4000 SERIES OSCILLATOR MASTER CARD (PC-407)



DIGITAL CONTROLLER
POWER SUPPLY CARD (PC-412)

DIGITAL CONTROLLER

RESISTORS

Symbol	Description			Mfr.	Part No.
R150	1.2K	10%	2W	AB	HB1221
R151	1.2K	10%	2W	AB	HB1221
R152	5.1K	5%	1/2W	AB	EB5125
R153	5.1K	5%	1/2W	AB	EB5125
R154	Trim			AB	TYPE EB
R155	2K	5%	1/2W	AB	EB2025
R156	1.1	5%	5W	WL	5X
R157	47	10%	1W	AB	GB4701
R158	1K	10%	1/2W	AB	EB1021
R159	5.1K	5%	1/2W	AB	EB5125
R160	27	5%	1/2W	AB	EB2705

CAPACITORS

Symbol	Description			Mfr.	Part No.
C150	2000mf	+75% -10%	30V	SP	D45349
C151	2000mf	+75% -10%	30V	SP	D45349
C152	25mf	+100% -10%	25V	SP	30D256G025CB4
C153	100mf	+100% -10%		SP	30D107G025DD4
C154	.47mf	20%	100V	EP	Z1X474K

TRANSISTORS, DIODES, & MISC.

Symbol	Description	Mfr.	Part No.
Q150	2N3638	FR	2N3638
Q151	2N3136	MO	2N3136
Q152	40319	RC	40319
Q154	2N3136	MO	2N3136
CR150	Rectifier	MO	MDA-952-2
CR151	Rectifier	MO	MDA-952-2
CR152	1N456	TR	1N456
CR153	1N456	TR	1N456
CR154	1N456	TR	1N456
CR155	1N456	TR	1N456
CR156	1N456	TR	1N456
CR157	1N456	TR	1N456
CR158	1N456	TR	1N456
CR159	1N456	TR	1N456
F150	Fuse (115V)	BU	MDL .4A
F150	Fuse (230V)	BU	MDL .2A
F151	Fuse	BU	MDX 1.5A
F152	Fuse	BU	MDX 1.5A
T150	Transformer	KH	P100-90
K150	Relay	BR	AR6650

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	MO	Motorola Semiconductor	Phoenix, Arizona
BR	Branson Corp.	Denville, N.J.	RC	Radio Corp. of America	Harrison, N.J.
BU	Bussmann Mfg. Div.	St. Louis, Mo.	SP	Sprague Electric Co.	North Adams, Mass.
EP	Elpac, Inc.	Fullerton, Calif.	TR	Transitron Electric Corp.	Wakefield, Mass.
FR	Fairchild Semiconductor	San Rafael, Calif.	WL	Ward Leonard Electric Co.	Mt. Vernon, N.Y.
KH	Krohn-Hite Corp.	Cambridge, Mass.			

SERIES 4000 OSCILLATOR

RESISTORS

Symbol	Description			Mfr.	Part No.
R701	100K	10%	1/4W	AB	CB1041
R702	200K	5%	1/4W	AB	CB2045
R709	100K	5%	1/4W	AB	CB1045
R710	100K	5%	1/4W	AB	CB1045
R711	21K	1%	1/2W	IR	CEC-TO
R711*	21K	0.05%	3/10W	VI	S102
R712	6.98K	1%	1/2W	IR	CEC-TO
R712*	6.98K	0.05%	3/10W	VI	S102
R713	5.1K	5%	1/4W	AB	CB5125
R714	20.4K	1%	1/2W	IR	CEC-TO
R714*	20.4K	0.05%	3/10W	VI	S102
R716	13M	5%	1/4W	AB	CB1365
R717	2M	5%	1/4W	AB	CB2055
R718	3.6M	5%	1/4W	AB	CB3655
R719	910K	5%	1/4W	AB	CB9145
R720	100K	5%	1/4W	AB	CB1045
R721	8	1%	1W	IR	AS1
R722	1.624K	1%	1/2W	IR	CEC-TO
R722*	1,623.6	0.05%	3/10W	VI	S102
R723	4.3M	5%	1/4W	AB	CB4355
R724	9.31M	1%	1/2W	IR	CEC-TX
R725	3M	5%	1/4W	AB	CB3055

Symbol	Description			Mfr.	
R726	6.8M	5%	1/4W	AB	CB6855
R727	2.7	5%	1/2W	AB	EB27G5
R728	6.19K	1%	1/2W	IR	CEC-TO
R729	6.19K	1%	1/2W	IR	CEC-TO
R730	3.9K	5%	1/4W	AB	CB3925
R731	10K	5%	1/4W	AB	CB1035
R794	330	10%	1/4W	AB	CB3111
R795	200	1%	1W	IR	AS1
R796	12K	5%	1/4W	AB	CB1235
R797	400	1%	1W	IR	AS1
R810	1.78K	1%	1W	IR	AS1
R811	20	1%	1W	IR	AS1
R812	2.2	5%	1/2W	AB	EB22G5
R813	2K	1%	1W	IR	AS1
R814	1K	1%	1W	IR	AS1
R815	1K	1%	1W	IR	AS1
R816	500	1%	1W	IR	AS1
R817	500	1%	1W	IR	AS1
R818	400	1%	1W	IR	AS1
R819	Trim			AB	Type EB
R840	400	1%	1W	IR	AS1

* Used in Model 4031R

CAPACITORS

Symbol	Description			Mfr.	Part No.
C701	1000mf	+100% -10%	50V	SP	62D
C702	500mf	+100% -10%	50V	SP	62D
C703	1mf	+75% -10%	50V	SP	30D105G050BA2
C704	0.04mf	20%	500V	SP	5GA-S40
C705	0.1mf	20%	50V	SP	33C41A3
C706	0.04mf	20%	500V	SP	5GA-S40
C710	15mmf	5%	500V	EL	DM15C150J
C711	5-18mmf			ER	538-006NPO(COPO) 5.5-18pf(92R)

Symbol	Description			Mfr.	Part No.
C712	0.001mf	10%	100V	CD	WMF1D1G
C714	2.5-11mmf			ER	538-006N300(B2PO) 2.5-11pf(90R)
C715	68mmf	5%	500V	EL	DM15C680J
C716	0.02mf	20%	500V	SP	29C369A3
C717	10mf	10%	50V	KH	B2266B
C718	10mf		50V	KH	B2266B
C724	10mf		50V	KH	B2266B
C731	220mmf	5%	500V	EL	DM15C221J
C810	220mmf	10%	500V	EL	DM15C221K
C811	220mmf	10%	500V	EL	DM15C221K

TRANSISTORS, DIODES, & MISC.

Symbol	Description			Part No.	
Q701	2N3055			RC	2N3055
Q702	2N3055			RC	2N3055
CR701	Rectifier			MO	MDA942-2
F701	Fuse (115V)			BU	MDL .4A
F701	Fuse (230V)			BU	MDL .2A
I701	Pilot Light			ED	EG03-CCBNE2
P701	1K	30%	1/4W	CT	U201

Symbol	Description			Mfr.	Part No.
P702	10K	20%	2W	AB	JAIL040S103MC
P703	100K	20%	2W	AB	JAIL040S104RC
S701	Power Switch			CH	8280K27H
S702	Slide Switch			CW	G123
S810 / P810	Switch and Potentiometer Assy.			KH	B2269D
T701	Transformer			KH	P100-87B

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	MO	Motorola Semiconductor	Phoenix, Ariz.
BR	Branson Corp.	Denville, N. J.	RC	Radio Corp. of Am.	Harrison, N. J.
BU	Bussmann Mfg. Div.	St. Louis, Mo.	SP	Sprague Elec. Co.	N. Adams, Mass.
FR	Fairchild Semiconductor	San Rafael, Calif.	TR	Transitron Electric Corp.	Wakefield, Mass.
KH	Krohn-Hite Corp.	Cambridge, Mass.	WL	Ward Leonard Electric Co.	Mt. Vernon, N. Y.

RESISTORS

Symbol	Description			Mfr.	Part No.
R201	49	1%	1W	IRC	AS-1
R202	1K	10%	1/2W	A-B	EB-1021
R203	1K	10%	1/2W	A-B	EB-1021
R204	510	5%	1/2W	A-B	EB-5115
R205	510	5%	1/2W	A-B	EB-5115
R206	1K	10%	1/2W	A-B	EB-1021
R207	2.7K	10%	1/2W	A-B	EB-2721
R208	24K	5%	1/2W	A-B	EB-2435
R209	2.7K	10%	1/2W	A-B	EB-2721
R210	24K	5%	1/2W	A-B	EB-2435
R211	24K	5%	1/2W	A-B	EB-2435
R212	1K	10%	1/2W	A-B	EB-1021
R213	1K	10%	1/2W	A-B	EB-1021
R214	510	5%	1/2W	A-B	EB-5115
R215	1K	10%	1/2W	A-B	EB-1021
R216	1K	10%	1/2W	A-B	EB-1021
R217	3.3K	10%	1/4W	A-B	CB-3321
R218	100K	10%	1/4W	A-B	CB-1041
R219	10K	5%	1/2W	A-B	EB-1035
R220	1K	5%	1/2W	A-B	EB-1025
R221	10K	5%	1/2W	A-B	EB-1035
R222	1.5K	5%	1/2W	A-B	EB-1525
R223	12K	5%	1/2W	A-B	EB-1235
R224	1.5K	10%	1/2W	A-B	EB-1521
R225	100	5%	1/2W	A-B	EB-1015
R226	750	5%	1/2W	A-B	EB-7515
R227	10K	5%	1/2W	A-B	EB-1035
R228	1K	5%	1/2W	A-B	EB-1025
R229	10K	5%	1/2W	A-B	EB-1035
R230	1.5K	5%	1/2W	A-B	EB-1525
R231	270	5%	1/2W	A-B	EB-2715
R232	300	5%	2W	A-B	HB-3015
R233	75	5%	1/2W	A-B	EB-7505
R234A	182	1%	1/2W	IRC	CEC-TO
R234B	182	1%	1/2W	IRC	CEC-TO
R235A	3.92K	1%	1/2W	IRC	CEC-TO
R235B	3.92K	1%	1/2W	IRC	CEC-TO
R236	301	1%	1/2W	IRC	CEC-TO
R237	620	5%	1/2W	A-B	EB-6215
R238	200	5%	1/2W	A-B	EB-2015
R239	160	5%	1/2W	A-B	EB-1615
R240	562	1%	1/2W	IRC	CEC-TO
R801	5.6K	10%	1/2W	A-B	EB-5621
R802	Trim			A-B	TYPE CB
R803	10K	10%	1/2W	A-B	EB-1031
R804	10K	10%	1/2W	A-B	EB-1031

CAPACITORS

Symbol	Description			Mfr.	Part No.
C201	22mmf	10%	500V	E1	DM15C220K
C202	5.1mmf	10%	500V	E1	DM15C 5.1K
C203	5.1mmf	10%	500V	E1	DM15C 5.1K
C204	22mmf	10%	500V	E1	DM15C220K
C205	22mmf	10%	500V	E1	DM15C220K
C206	22mmf	10%	500V	E1	DM15C220K
C207	100mmf	10%	500V	E1	DM15C101K
C208	1mf	20%	35V	Sp	150D105X0035A2
C209	15mf	20%	50V	Sp	150D156X0050R2
C801	0.1mf	10%	100V	C-D	WMF1S1
C802	1000mmf	10%	100V	C-D	WMF1D1
C803	100mmf	10%	500V	EL	DM15C101K

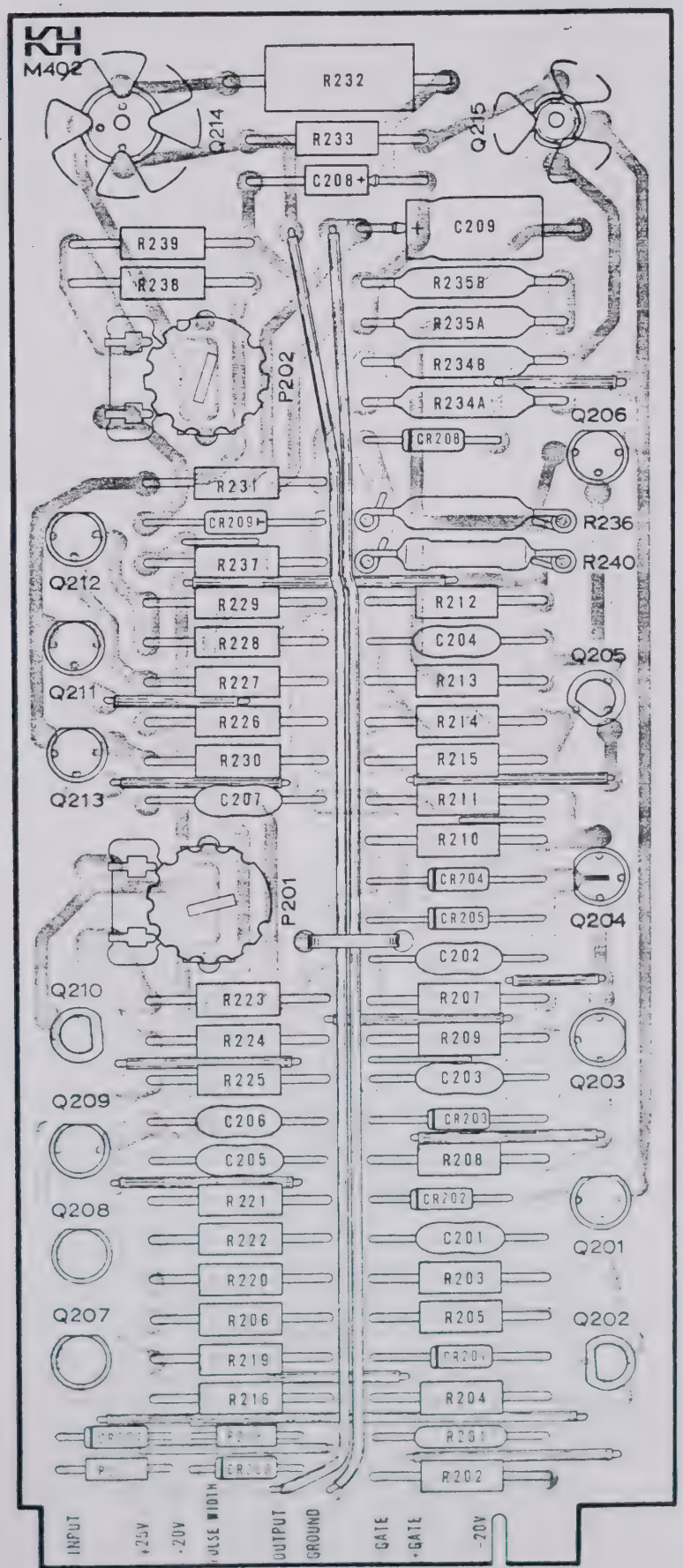
TRANSISTORS, DIODES, & MISC.

Symbol	Description	Mfr.	Part No.
Q201	2N3646	Fair	2N3646
Q202	2N3708	TI	2N3708
Q203	2N3646	Fair	2N3646
Q204	2N3646	Fair	2N3646
Q205	2N3708	TI	2N3708
Q206	2N3646	Fair	2N3646
Q207	2N3646	Fair	2N3646
Q208	2N3646	Fair	2N3646
Q209	2N3646	Fair	2N3646
Q210	2N3708	TI	2N3708
Q211	2N3646	Fair	2N3646
Q212	2N3646	Fair	2N3646
Q213	2N3646	Fair	2N3646
Q214	2N3638	Fair	2N3638
Q215	2N3646	Fair	2N3646

Symbol	Description			Mfr.	Part No.
CR201	SG5445			TRAN	SG5445
CR202	SG5445			TRAN	SG5445
CR203	SG5445			TRAN	SG5445
CR204	SG5445			TRAN	SG5445
CR205	SG5445			TRAN	SG5445
CR206	SG5445			TRAN	SG5445
CR207	SG5445			TRAN	SG5445
CR208	SG5445			TRAN	SG5445
CR209	1N456			TRAN	1N456
P201	1K	30%	1/4W	CTS	U-201 R102B
P202	500	30%	1/4W	CTS	U-201 R501B
S801, P801	Switch and Pot. Assy.			KH	B2328D
P802	60	20%	1/2W	A-B	GW6954

MANUFACTURERS CODE

A-B	Allen-Bradley Co.	Milwaukee, Wis.	IRC	International Resistance Co.	Philadelphia, Pa.
C-D	Cornell-Dubilier Elec. Co.	South Plainfield, N.J.	K-H	Krohn-Hite Corp.	Cambridge, Mass.
CTS	CTS Corp.	Elkhart, Ind.	Sp	Sprague Electric Co.	North Adams, Mass.
EL	Electro Motive Mfg. Inc.	Willimantic, Conn.	TI	Texas Instruments, Inc.	Dallas, Texas
Fair	Fairchild Semiconductor	San Rafael, Calif.	TRAN	Transitron Electronic Corp.	Wakefield, Mass.


M402
R232
R233
C208
C209
Q214
Q215
R239
R238
R235B
R235A
R234B
R234A
Q206
CR208
P202
R231
CR209
R236
R240
R237
Q212
R229
R212
R228
C204
Q205
Q211
R227
R213
R226
R214
R230
R215
Q213
C207
R211
R210
CR204
P201
CR205
Q204
C202
Q210
R223
R207
R224
R209
Q203
R225
C203
Q209
C206
CR203
C205
R208
Q208
R221
CR202
R222
C201
Q201
R220
R203
Q207
R206
R205
Q202
R219
CR201
R216
R204
R217
R218
R202
INPUT
+25V
-20V
PULSE WIDTH
OUTPUT
GROUND
GATE
-GATE
-20V

RESISTORS

Symbol	Description			Mfr.	Part No.
R301	49	1%	1W	IRC	AS-1
R302	1K	10%	1/2W	A-B	EB-1021
R303	1K	5%	1/2W	A-B	EB-1025
R304	4.7K	10%	1/2W	A-B	EB-4721
R305	24K	5%	1/2W	A-B	EB-2435
R306	4.7K	10%	1/2W	A-B	EB-4721
R307	24K	5%	1/2W	A-B	EB-2435
R308	1K	10%	1/2W	A-B	EB-1021
R309	3.3K	10%	1/2W	A-B	EB-3321
R310	100K	10%	1/2W	A-B	EB-1041
R311	10K	5%	1/2W	A-B	EB-1035
R312	1K	5%	1/2W	A-B	EB-1025
R313	10K	5%	1/2W	A-B	EB-1035
R314	1.5K	5%	1/2W	A-B	EB-1525
R315	12K	5%	1/2W	A-B	EB-1235

Symbol	Description			Mfr.	Part No.
R316	1.5K	10%	1/2W	A-B	EB-1521
R317	100	5%	1/2W	A-B	EB-1015
R318	300	5%	2W	A-B	HB-3015
R319	75	5%	1/2W	A-B	EB-7505
R320A	182	1%	1/2W	IRC	CEC-TO
R320B	182	1%	1/2W	IRC	CEC-TO
R321A	3.92K	1%	1/2W	IRC	CEC-TO
R321B	3.92K	1%	1/2W	IRC	CEC-TO
R322	301	1%	1/2W	IRC	CEC-TO
R323	620	5%	1/2W	A-B	EB-6215
R324	200	5%	1/2W	A-B	EB-2015
R325	160	5%	1/2W	A-B	EB-1615
R326	562	1%	1/2W	IRC	CEC-TO
R802	Trim			A-B	TYPE CB

CAPACITORS

Symbol	Description			Mfr.	Part No.
C301	5.1mmf	10%	500V	EL	DM15C5.1K
C302	5.1mmf	10%	500V	EL	DM15C5.1K
C303	22mmf	10%	500V	EL	DM15C220K

Symbol	Description			Mfr.	Part No.
C304	22mmf	10%	500V	EL	DM15C220K
C305	1mf	20%	35V	SP	150D105X0035A2
C306	15mf	20%	50V	SP	150D156X0050R2

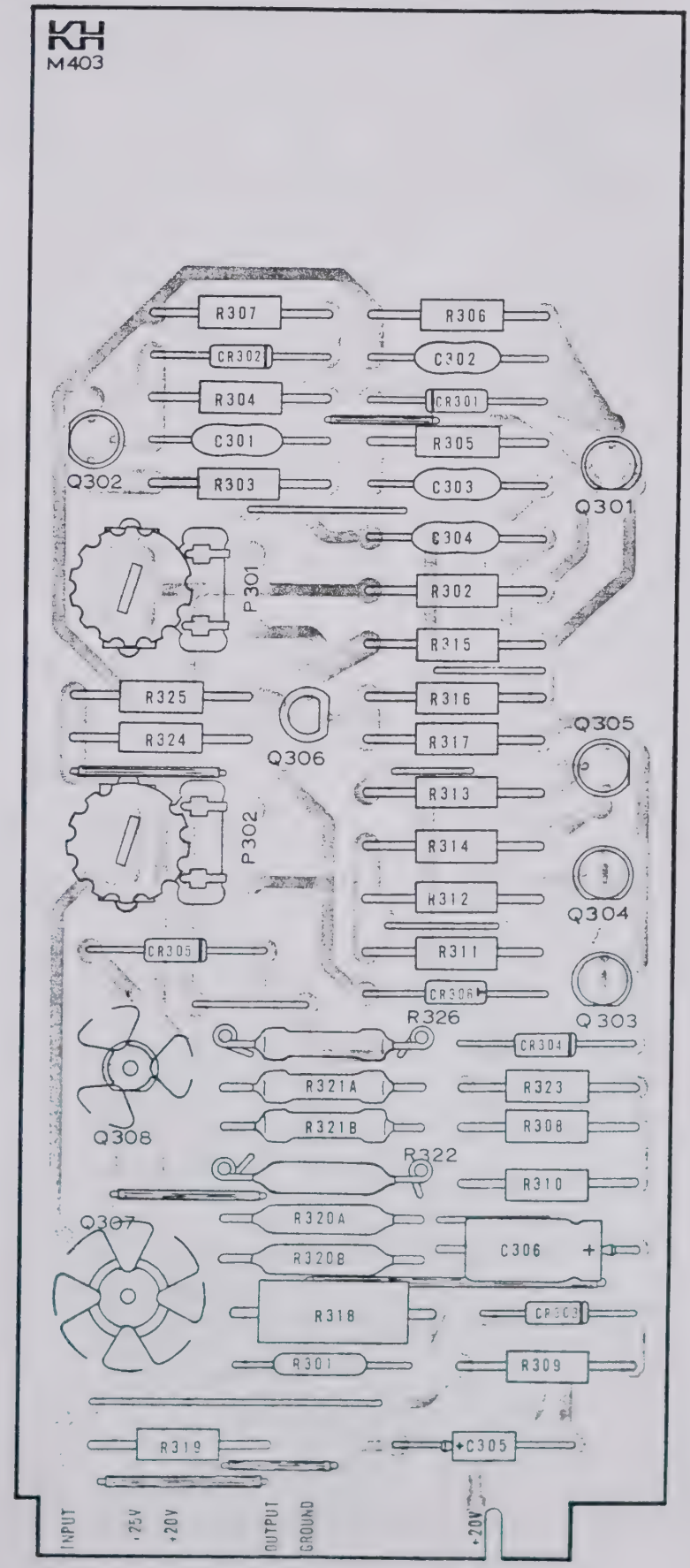
TRANSISTORS, DIODES, & MISC.

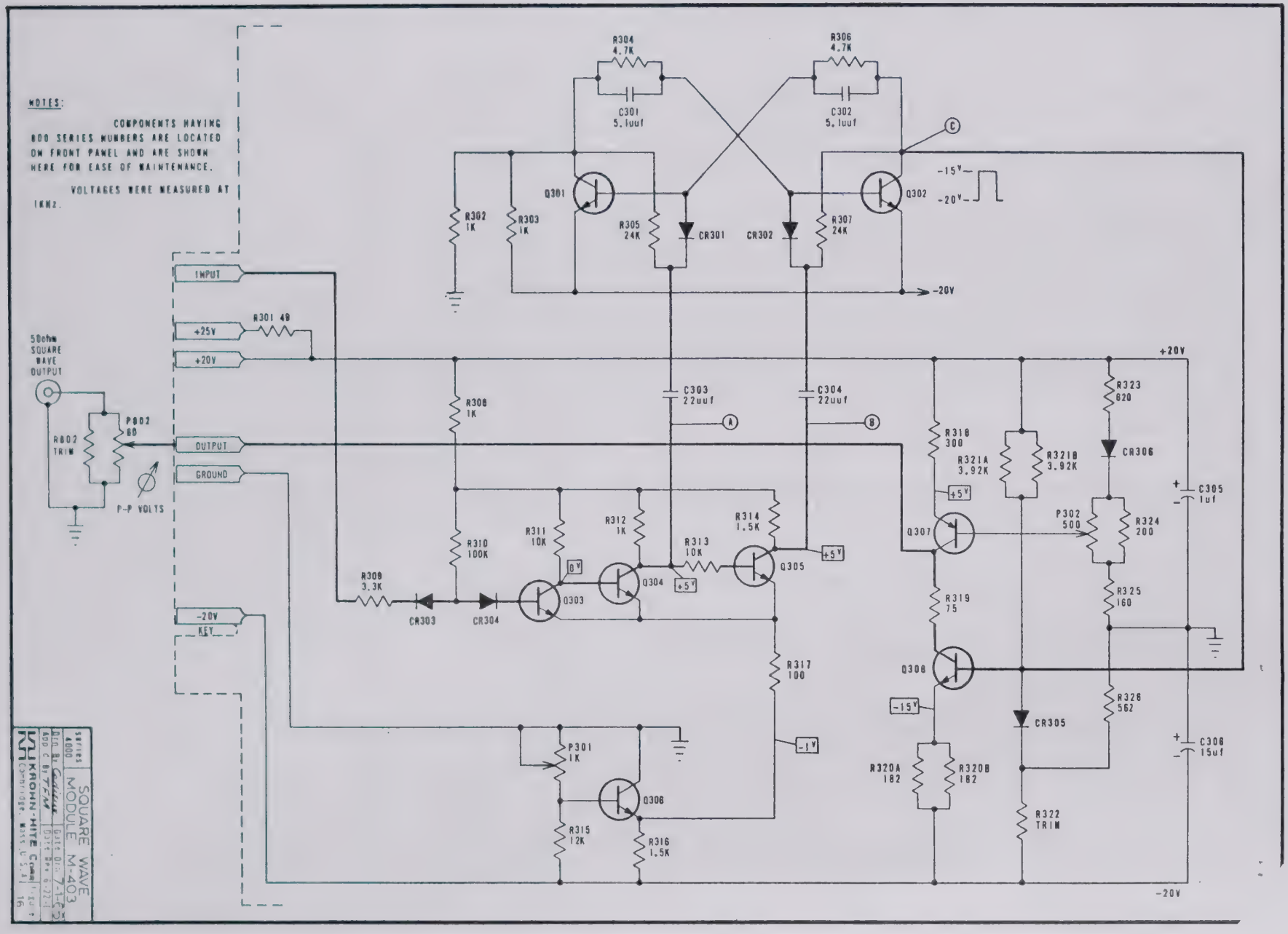
Symbol	Description	Mfr.	Part No.
Q301	2N3646	Fair	2N3646
Q302	2N3646	Fair	2N3646
Q303	2N3646	Fair	2N3646
Q304	2N3646	Fair	2N3646
Q305	2N3646	Fair	2N3646
Q306	2N3708	TI	2N3708
Q307	2N3638	Fair	2N3638
Q308	2N3646	Fair	2N3646
CR301	SG5445	TRAN	SG5445

Symbol	Description			Mfr.	Part No.
CR302	SG5445			TRAN	SG5445
CR303	SG5445			TRAN	SG5445
CR304	SG5445			TRAN	SG5445
CR305	SG5445			TRAN	SG5445
CR306	1N456			TRAN	IN456
P301	1K	30%	1/4W	CTS	U201 R102B
P302	500	30%	1/4W	CTS	U201 R501B
P802	60	20%	1/2W	AB	GW6954

MANUFACTURERS CODE

A-B	Allen-Bradley Co.	Milwaukee, Wis.	IRC	International Resistance Co.	Philadelphia, Pa.
CTS	CTS Corp.	Elkhart, Ind.	Sp	Sprague Electric Co.	North Adams, Mass.
El	Electro Motive Mfg. Inc.	Willimantic, Conn.	TI	Texas Instruments, Inc.	Dallas, Texas
Fair	Fairchild Semiconductor	San Rafael, Calif.	TRAN	Transitron Electronic Corp.	Wakefield, Mass.


M403
R307
R306
CR302
C302
R304
CR301
C301
R305
Q302
R303
C303
Q301
C304
P301
R302
R315
R325
R316
Q305
R324
Q306
R317
R313
P302
R314
Q304
R312
CR305
R311
CR306
R326
Q303
CR304
R321A
R323
R321B
R308
R322
Q308
R310
R320A
Q307
C306
R320B
R318
CR303
R301
R309
R319
C305
INPUT
-25V
+20V
OUTPUT
GROUND
+20V


NOTES:
COMPONENTS HAVING 800 SERIES NUMBERS ARE LOCATED ON FRONT PANEL AND ARE SHOWN HERE FOR EASE OF MAINTENANCE.
VOLTAGES WERE MEASURED AT 1KHz.
R304 4.7K
R306 4.7K
C301 5.1uuf
C302 5.1uuf
Q301
Q302
-15V
-20V
R302 1K
R303 1K
R305 24K
CR301
CR302
R307 24K
-20V
INPUT
+25V
+20V
R301 49
50ohm SQUARE WAVE OUTPUT
P802 80
R802 TRIM
OUTPUT
GROUND
P-P VOLTS
R308 1K
C303 22uuf
C304 22uuf
A
B
R310 100K
R311 10K
R312 1K
R313 10K
R314 1.5K
Q303
Q304
Q305
0V
+5V
R309 3.3K
CR303
CR304
-20V KEY
R317 100
-1V
P301 1K
Q306
R315 12K
R316 1.5K
+20V
R318 300
R321A 3.92K
R321B 3.92K
R323 620
CR306
C305 1uf
Q307
P302 500
R324 200
R325 160
R319 75
Q308
-15V
CR305
R328 562
C306 15uf
R320A 182
R320B 182
R322 TRIM
-20V
SERIES 800
SQUARE WAVE MODULE M-403
Dwn. By Gadsden Date Dwn. 7-1-63
App'd. By Tyler Date Rev. 6-27-64
KUTHORN-HITE Company Boston, Mass. U.S.A.

RESISTORS

Symbol	Description	Mfr.	Part No.
R901-1	4K 1/4% 1/2W	IR	CEC-TO
R901-1*	4K 0.05% 3/10W	VI	S102
R901-2	40K 1/4% 1/2W	IR	CEC-TO
R901-2*	40K 0.05% 1/2W	VI	S104
R901-3	400K 1/4% 1/2W	IR	CEC-TO
R901-3*	400K 0.05% 1/4W	JE	JXP65
R901-4	4M 1% 1/2W	IR	DCC
R902-1	8K 1/4% 1/2W	IR	CEC-TO
R902-1*	8K 0.05% 3/10W	VI	S102
R902-2	80K 1/4% 1/2W	IR	CEC-TO
R902-2*	80K 0.05% 1W	VI	S106
R902-3	800K 1/4% 1/2W	IR	CEC-TO
R902-3*	800K 0.05% 1/4W	JE	JXP65
R902-4	8M 1% 1/2W	IR	DCC
R903-1	same as R902-1 or R902-1*		
R903-2	same as R902-2 or R902-2*		
R903-3	same as R902-3 or R902-3*		
R903-4	8M 1% 1/2W	IR	DCC
R904-1	same as R901-1 or R901-1*		
R904-2	same as R901-2 or R901-2*		
R904-3	same as R901-3 or R901-3*		
R904-4	4M 1% 1/2W	IR	DCC
R905-1	same as R902-1 or R902-1*		
R905-2	same as R902-2 or R902-2*		
R905-3	same as R902-3 or R902-3*		
R905-4	8M 1% 1/2W	IR	DCC
R906-1	same as R902-1 or R902-1*		
R906-2	same as R902-2 or R902-2*		
R906-3	same as R902-3 or R902-3*		
R906-4	8M 1% 1/2W	IR	DCC
R907-1	same as R902-1 or R902-1*		
R907-2	same as R902-2 or R902-2*		
R907-3	same as R902-3 or R902-3*		
R907-4	8M 1% 1/2W	IR	DCC
R908-1	16K 1/4% 1/2W	IR	CEC-TO
R908-1*	16K 0.05% 3/10W	VI	S102
R908-2	160K 1/4% 1/2W	IR	CEC-TO
R908-2*	160K 0.05% 1/4W	JE	JXP65
R908-3	1.6M 1/4% 1/2W	IR	CEC-TO
R908-3*	1.6M 0.05% 1/2W	JE	JXP70
R908-4	16M 2% 1/2W	IR	DCC
R909-1	same as R908-1 or R908-1*		
R909-2	same as R908-2 or R908-2*		
R909-3	same as R908-3 or R908-3*		
R909-4	16M 2% 1/2W	IR	DCC
R910-1	same as R908-1 or R908-1*		
R910-2	same as R908-2 or R908-2*		
R910-3	same as R908-3 or R908-3*		
R910-4	16M 2% 1/2W	IR	DCC
R911-1	32K 1/4% 1/2W	IR	CEC-TO
R911-1*	32K 0.05% 1/2W	VI	S104
R911-2	320K 1/4% 1/2W	IR	CEC-TO
R911-2*	320K 0.05% 1/4W	JE	JXP65
R911-3	2K 1/4% 1/2W	IR	CEC-TO
R911-3*	1K 0.05% 3/10W	VI	S102
R911-4	100K 1/4% 1/2W	IR	CEC-TO
R911-4*	10K 0.05% 3/10W	VI	S102
R912-1	same as R911-1 or R911-1*		
R912-2	same as R911-2 or R911-2*		
R912-3	same as R911-3 or R911-3*		
R912-4	same as R911-4 or R911-4*		
R913-3	same as R908-3 or R908-3*		
R913-4	16M 2% 1/2W	IR	DCC
R930	5.1K 5% 1/4W	AB	CB5125
R931	1K 10% 1/4W	AB	CB1021
R932	1K 10% 1/4W	AB	CB1021
R933	1K 10% 1/4W	AB	CB1021
R934	1K 10% 1/4W	AB	CB1021
R935	1K 10% 1/4W	AB	CB1021
R936	10K 10% 1/4W	AB	CB1031
R937	27 10% 1/4W	AB	CB2701
R938	1K 10% 1/4W	AB	CB1021
R939	1K 10% 1/4W	AB	CB1021
R940	1K 10% 1/4W	AB	CB1021
R941	10K 10% 1/4W	AB	CB1031
R942	27 10% 1/4W	AB	CB2701
R943	1K 10% 1/4W	AB	CB1021
R944	1K 10% 1/4W	AB	CB1021
R945	1K 10% 1/4W	AB	CB1021
R946	10K 10% 1/4W	AB	CB1031
R947	27 10% 1/4W	AB	CB2701
R948	1K 10% 1/4W	AB	CB1021
R949	1K 10% 1/4W	AB	CB1021
R950	1K 10% 1/4W	AB	CB1021
R951	10K 10% 1/4W	AB	CB1031
R952	27 10% 1/4W	AB	CB2701

* Used in Model 4031R

CAPACITORS

Symbol	Description	Mfr.	Part No.
C901	0.47mf 20% 100V	EP	21X474K
C902	0.01mf 10% 100V	CD	WMF1S1
C903	0.47mf 20% 100V	EP	21X474K
C904	0.01mf 10% 100V	CD	WMF1S1
C905	0.47mf 20% 100V	EP	21X474K
C906	0.01mf 10% 100V	CD	WMF1S1
C907	0.47mf 20% 100V	EP	21X474K
C908	0.01mf 10% 100V	CD	WMF1S1
C909	Trim	JE	Type JM
C910	Trim	JE	Type JM
C911	Trim	JE	Type JM
C912	Trim	JE	Type JM

TRANSISTORS, DIODES, & MISC.

Symbol	Description	Mfr.	Part No.
Q901	2N3053	MO	2N3053
Q902	2N3136	MO	2N3136
Q903	2N3136	MO	2N3136
Q904	2N3136	MO	2N3136
Q905	2N3136	MO	2N3136
CR901	1N456	TR	1N456
CR902	1N456	TR	1N456
CR903	1N456	TR	1N456
CR904	1N456	TR	1N456
CR905	1N456	TR	1N456
CR906	1N456	TR	1N456
CR907	1N456	TR	1N456
CR908	1N456	TR	1N456
CR909	1N456	TR	1N456
SCR901	Silicon control rectifier	GE	C106Y2
SCR902	Silicon control rectifier	GE	C106Y2
SCR903	Silicon control rectifier	GE	C106Y2
SCR904	Silicon control rectifier	GE	C106Y2
K901	Relay	BR	AR6550
K902	Relay	BR	AR6550
K903	Relay	BR	AR6550
K904	Relay	BR	AR6550

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	IR	International Resistance Co.	Philadelphia, Pa.
BR	Branson Corp.	Denville, N. J.	JE	Jeffers Electronics	Dubois, Pa.
CD	Cornell-Dubilier Elec.	Newark, N. J.	MO	Motorola Semiconductor	Phoenix, Ariz.
EP	Elpac, Inc.	Fullerton, Calif.	TR	Transitron Electric Corp.	Wakefield, Mass.
GE	General Electric Co.	Syracuse, N. Y.	VI	Vishay Inst., Inc.	Malvern, Pa.

R913
R911
R912
C912
K904
R948
R910
R908
R909
C911
K903
R943
R907
R905
R906
C910
K902
R938
R904
R902
R903
C909
K901
R933
R901
C907
SCR904
C908
CR908
R949
R950
R951
R952
Q905
I-1
C905
SCR903
C906
CR907
R944
R945
R946
R947
Q904
I-2
C903
SCR902
C904
CR906
R939
R940
R941
R942
C902
CR905
R935
Q903
I-4
C901
SCR901
R936
R934
R937
Q902
Q901
R931
R930
CR904
I-1
I-2
I-4
I-8
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E1
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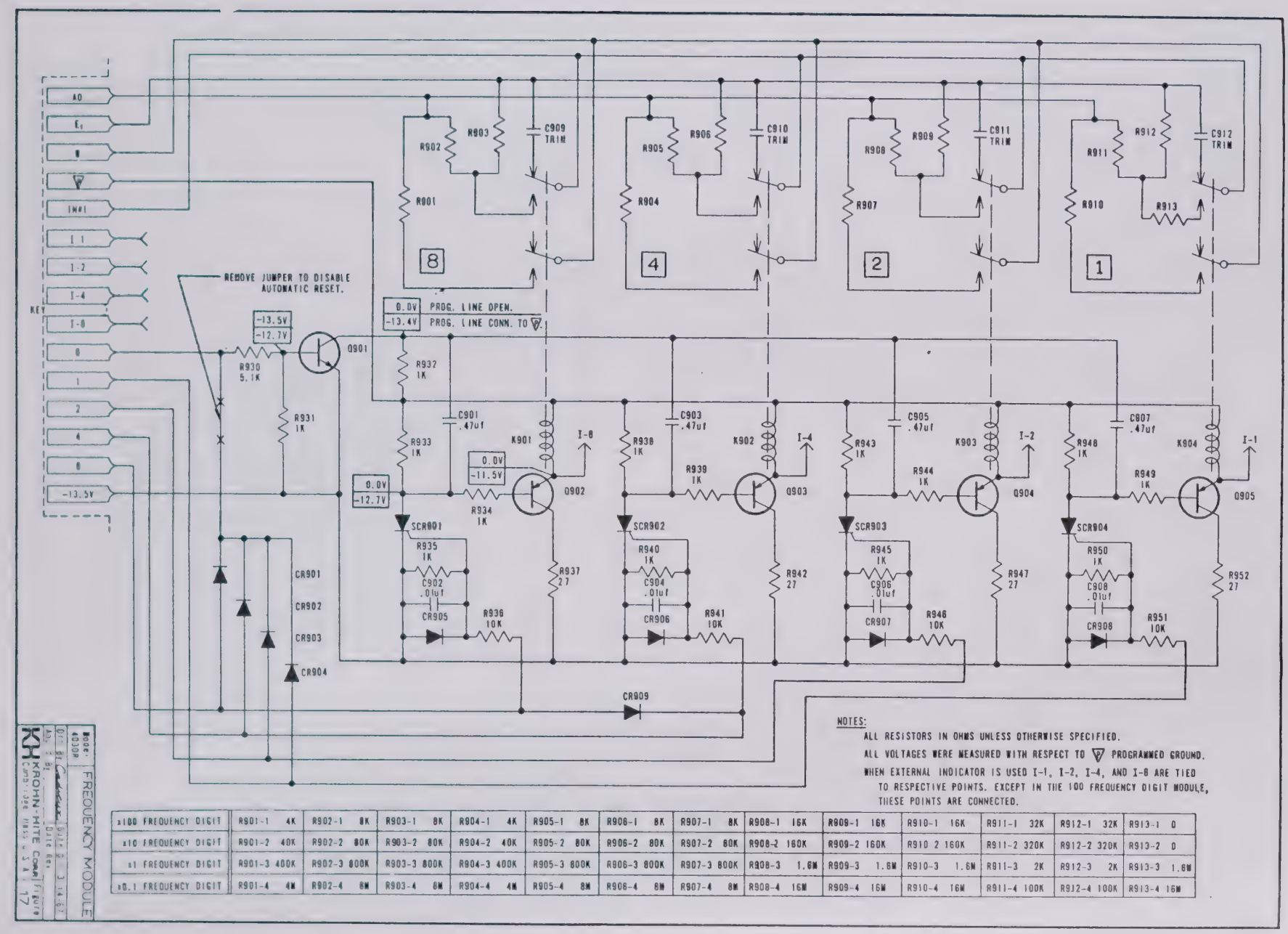
8
-13.5V



NOTES:

ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED.

ALL VOLTAGES WERE MEASURED WITH RESPECT TO ▽ PROGRAMMED GROUND.

WHEN EXTERNAL INDICATOR IS USED I-1, I-2, I-4, AND I-8 ARE TIED TO RESPECTIVE POINTS. EXCEPT IN THE 100 FREQUENCY DIGIT MODULE, THESE POINTS ARE CONNECTED.

x100 FREQUENCY DIGIT	R901-1 4K	R902-1 8K	R903-1 8K	R904-1 4K	R905-1 8K	R906-1 8K	R907-1 8K	R908-1 16K	R909-1 16K	R910-1 16K	R911-1 32K	R912-1 32K	R913-1 0
x10 FREQUENCY DIGIT	R901-2 40K	R902-2 80K	R903-2 80K	R904-2 40K	R905-2 80K	R906-2 80K	R907-2 80K	R908-2 160K	R909-2 160K	R910 2 160K	R911-2 320K	R912-2 320K	R913-2 0
x1 FREQUENCY DIGIT	R901-3 400K	R902-3 800K	R903-3 800K	R904-3 400K	R905-3 800K	R906-3 800K	R907-3 800K	R908-3 1.6M	R909-3 1.6M	R910-3 1.6M	R911-3 2K	R912-3 2K	R913-3 1.6M
x0.1 FREQUENCY DIGIT	R901-4 4M	R902-4 8M	R903-4 8M	R904-4 4M	R905-4 8M	R906-4 8M	R907-4 8M	R908-4 16M	R909-4 16M	R910-4 16M	R911-4 100K	R912-4 100K	R913-4 16M

Model 4030R

FREQUENCY MODULE

KROHN-HITE CORPORATION

Dwn. By: Date: 2-3-67

Chk. By: Date Rev.

Contract No. 5-41-17

RESISTORS

Symbol	Description			Mfr.	Part No.
R960	5.1K	10%	1/4W	AB	CB5121
R961	1K	10%	1/4W	AB	CB1021
R962	1K	10%	1/4W	AB	CB1021
R963	1K	10%	1/4W	AB	CB1021
R964	1K	10%	1/4W	AB	CB1021
R965	1K	10%	1/4W	AB	CB1021
R966	10K	10%	1/4W	AB	CB1031
R967	27	10%	1/2W	AB	EB2701
R968	1K	10%	1/4W	AB	CB1021
R969	1K	10%	1/4W	AB	CB1021

Symbol	Description			Mfr.	Part No.
R970	1K	10%	1/4W	AB	CB1021
R971	10K	10%	1/4W	AB	CB1031
R972	27	10%	1/2W	AB	EB2701
R973	Trim			AB	TYPE EB
R974	Trim			IR	CEC-TO
R975	Trim			AB	TYPE EB
R976	15K	10%	1/4W	AB	CB1531
R977	15K	10%	1/4W	AB	CB1531
R978	Trim			AB	TYPE EB
R979	Trim			AB	TYPE EB

CAPACITORS

Symbol	Description			Mfr.	Part No.
C961	.47mf	20%	100V	EP	Z1X47K
C962	.01mf	10%	100V	CD	WMF1S1
C963	.47mf	20%	100V	EP	Z1X47K
C964	.01mf	10%	100V	CD	WMF1S1
C965A	0.099mf	±1/4%	50V	EP	BX4841F
C965A*	0.099mf	±0.05%	50V	KH	CPS104
C965B	Trim				
C966A	0.009mf	±1/4%	300V	EL	DM20
C966A*	0.009mf	±0.05%	50V	KH	CPS103
C966B	Trim				
C967A	0.099mf	±1/4%	50V	EP	BX4841F
C967A*	0.099mf	±0.05%	50V	KH	CPS104

Symbol	Description			Mfr.	Part No.
C967B	Trim			CD	TYPE WMF
C968A	0.009mf	±1/4%	300V	CD	TYPE WMF
C968A*	0.009mf	±0.05%	50V	KH	CPS103
C968B	Trim				
C969	910pf	1%	500V	EL	CM20D911F
C970	910pf	1%	500V	EL	CM20D911F
C971	7-100pf			EL	#423
C972	7-100pf			EL	#423
C973	Trim				
C974	4.7mf	20%	6V	SP	150D475X006B2

*Used in Model 4031R

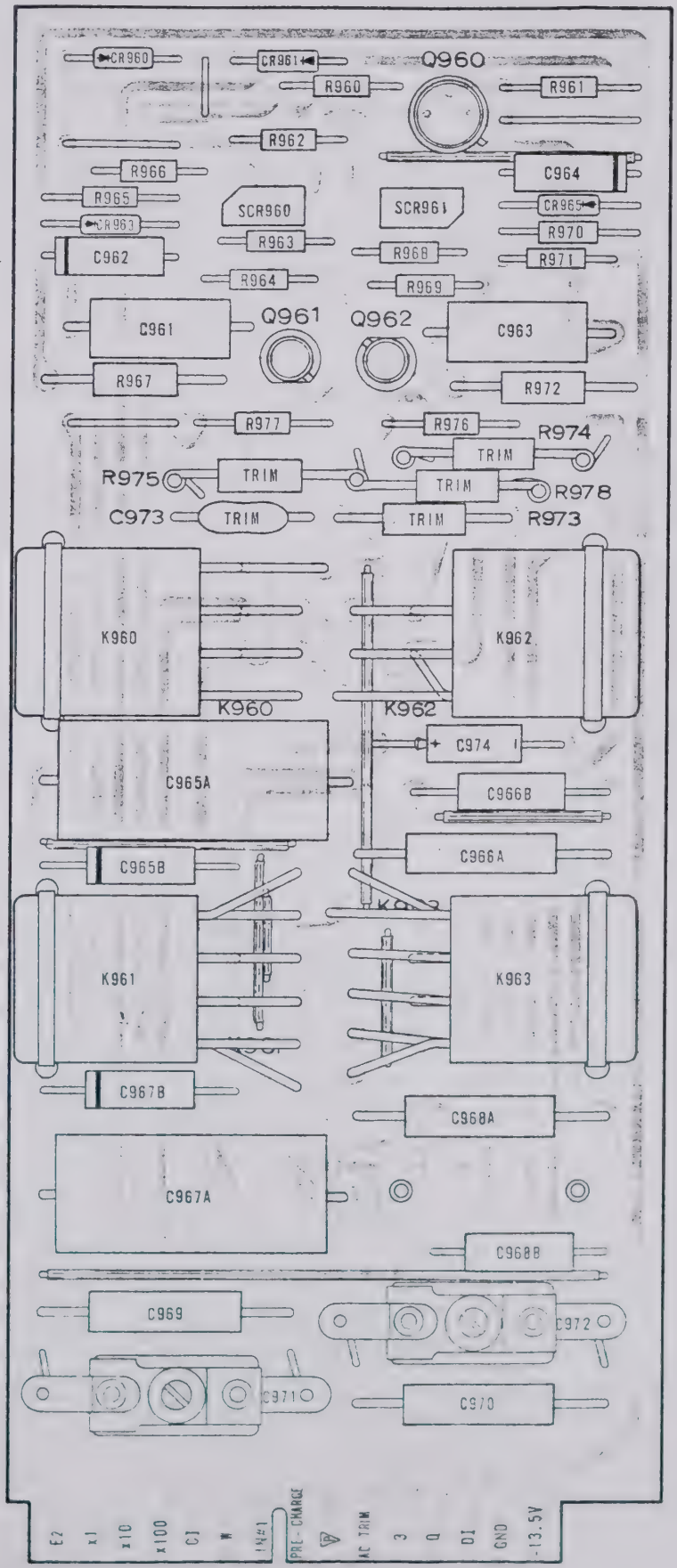
TRANSISTORS, DIODES, & MISC.

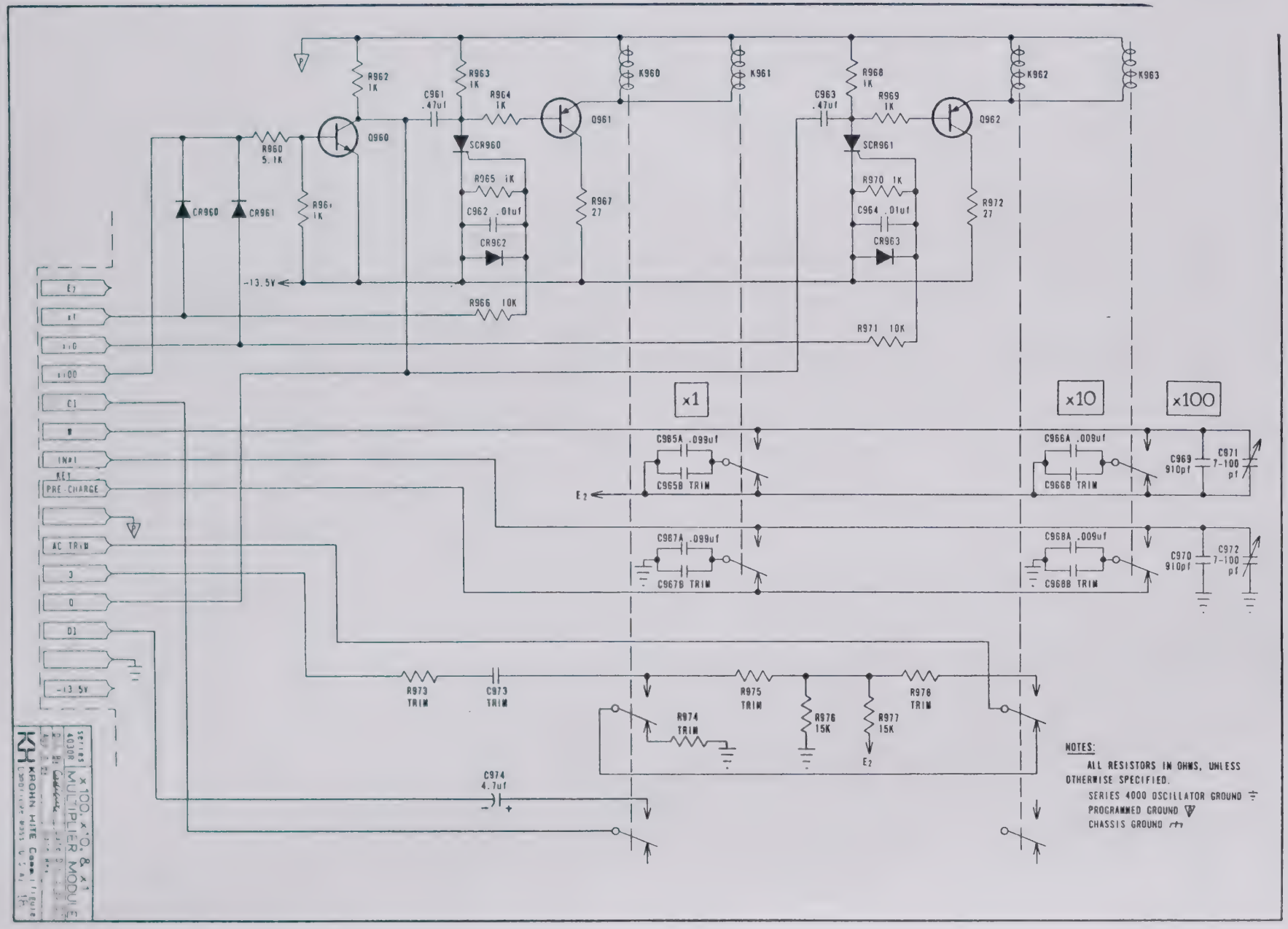
Symbol	Description	Mfr.	Part No.
Q960	2N3053	RC	2N3053
Q961	2N3136	MO	2N3136
Q962	2N3136	MO	2N3136
CR960	1N456	TR	1N456
CR961	1N456	TR	1N456
CR962	1N456	TR	1N456
CR963	1N456	TR	1N456

Symbol	Description	Mfr.	Part No.
SCR960	SCR Rectifier	GE	C106Y2
SCR961	SCR Rectifier	GE	C106Y2
K960	Relay DPDT	BR	AR6550
K961	Relay DPDT	BR	AR6550
K962	Relay DPDT	BR	AR6550
K963	Relay DPDT	BR	AR6550

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	IR	International Resistance Co.	Philadelphia, Pa.
BR	Branson Corp.	Denville, N. J.	KH	Krohn-Hite Corp.	Cambridge, Mass.
CD	Cornell-Dubilier Elec.	Newark, N. J.	MO	Motorola Semiconductor	Phoenix, Ariz.
EL	Electro Motive Mfg. Inc.	Willimantic, Conn.	RC	Radio Corp. of America	Hanson, N. J.
EP	Elpac Inc.	Fullerton, Calif.	SP	Sprague Electric Co.	North Adams, Mass.
GE	General Electric Co.	Syracuse, N. Y.	TR	Transitron Electric Corp.	Wakefield, Mass.


CR960
CR961
Q960
R960
R961
R962
R966
R965
CR963
SCR960
SCR961
CR965
C964
R970
R971
C962
R963
R968
R964
R969
C961
Q961
Q962
C963
R967
R972
R977
R976
R974
TRIM
R975
TRIM
TRIM
R978
C973
TRIM
TRIM
R973
K960
K962
K960
K962
C974
C965A
C966B
C965B
C966A
K961
K963
C967B
C968A
C967A
C968B
C969
C972
C971
C970
E2
x1
x10
x100
C1
PRE-CHARGE
AC TRIM
3
Q
D1
GND
-13.5V


R962 1K
R963 1K
C961 .47uf
R964 1K
K960
K961
R968 1K
C963 .47uf
R969 1K
K962
K963
Q960
Q961
Q962
SCR960
SCR961
R960 5.1K
R965 1K
C962 .01uf
CR962
R967 27
R970 1K
C964 .01uf
CR963
R972 27
CR960
CR961
R96x 1K
-13.5V
R966 10K
R971 10K
E2
x1
x10
x100
C1
B
INH1
KEY
PRE-CHARGE
AC TRIM
3
0
D1
-13.5V
x1
x10
x100
C965A .099uf
C965B TRIM
C966A .009uf
C966B TRIM
C969 910pf
C971 7-100 pf
C967A .099uf
C967B TRIM
C968A .009uf
C968B TRIM
C970 910pf
C972 7-100 pf
R973 TRIM
C973 TRIM
R974 TRIM
R975 TRIM
R976 15K
R977 15K
R978 TRIM
E2
C974 4.7uf
NOTES:
ALL RESISTORS IN OHMS, UNLESS OTHERWISE SPECIFIED.
SERIES 4000 OSCILLATOR GROUND
PROGRAMMED GROUND
CHASSIS GROUND
KROHN HITE
SERIES 4030R
x100, x10, & x1 MULTIPLIER MODULE

RESISTORS

Symbol	Description			Mfr.	Part No.
R980**	1K	10%	1/4W	AB	CB1021
R981**	1K	10%	1/4W	AB	CB1021
R982**	1K	10%	1/4W	AB	CB1021
R983**	10K	10%	1/4W	AB	CB1031
R984**	27	10%	1/2W	AB	EB2701
R985	1K	10%	1/4W	AB	CB1021
R986	1K	10%	1/4W	AB	CB1021
R987	1K	10%	1/4W	AB	CB1021
R988	10K	10%	1/4W	AB	CB1031
R989	27	10%	1/2W	AB	EB2701
R990**	Trim			AB	TYPE EB
R991	15K	5%	1/4W	AB	CB1535
R992	15K	5%	1/4W	AB	CB1535
R993	Trim			AB	TYPE EB

**Used in .01 Multiplier

CAPACITORS

Symbol	Description			Mfr.	Part No.
C980**	.47mf	20%	100V	EP	21X47K
C981**	.01mf	10%	100V	CD	WMF1S1
C982	.47mf	20%	100V	EP	21X47K
C983	.01mf	10%	100V	CD	WMF1S1
C984A	1mf	±1/4%	50V	EP	BX4842
C984A*	1mf	±0.05%	50V	KH	CPS105
C984B	Trim				
C985A	1mf	±1/4%	50V	EP	BX4842
C985A*	1mf	±0.05%	50V	KH	CPS105
C985B	Trim				
C986	47mf	±20%	6V	SP	150D

* Used in Model 4031R

**Used in .01 Multiplier

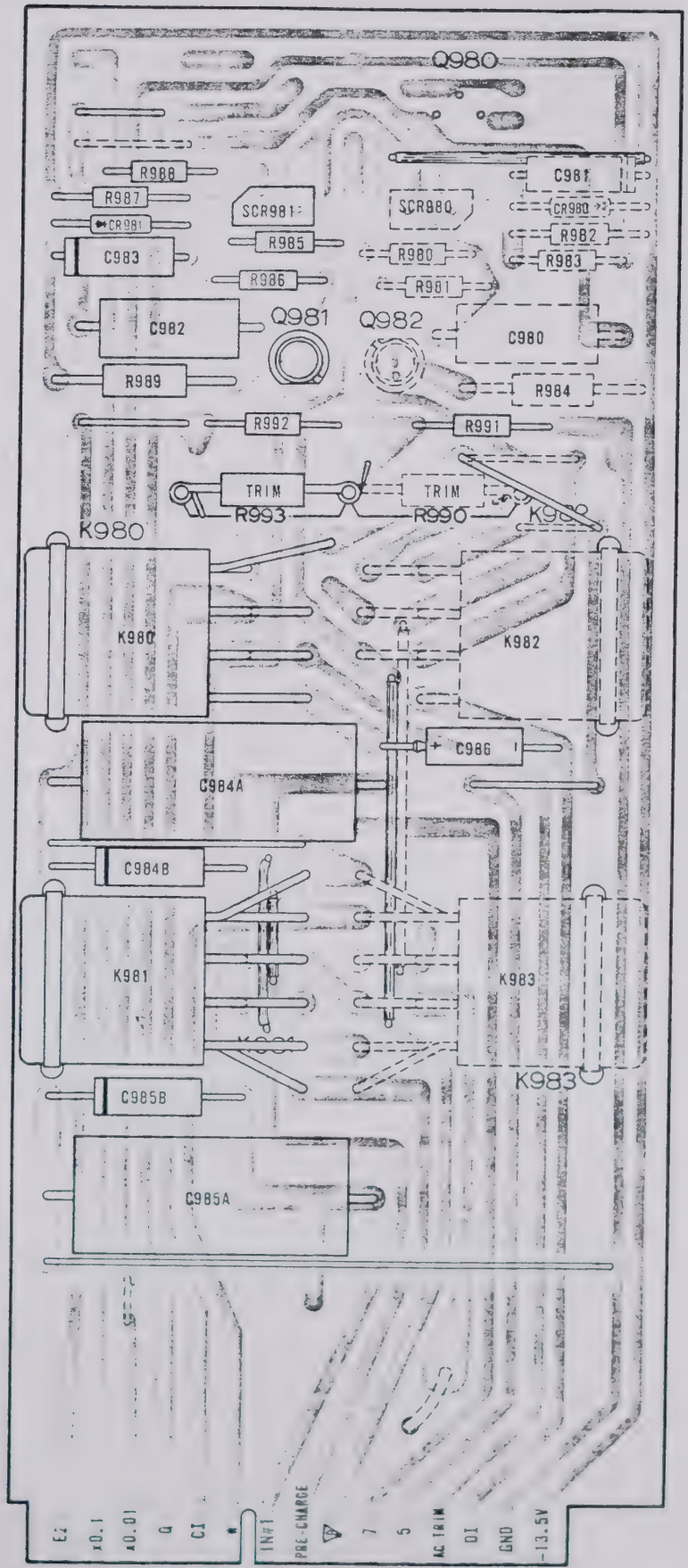
TRANSISTORS, DIODES, & MISC.

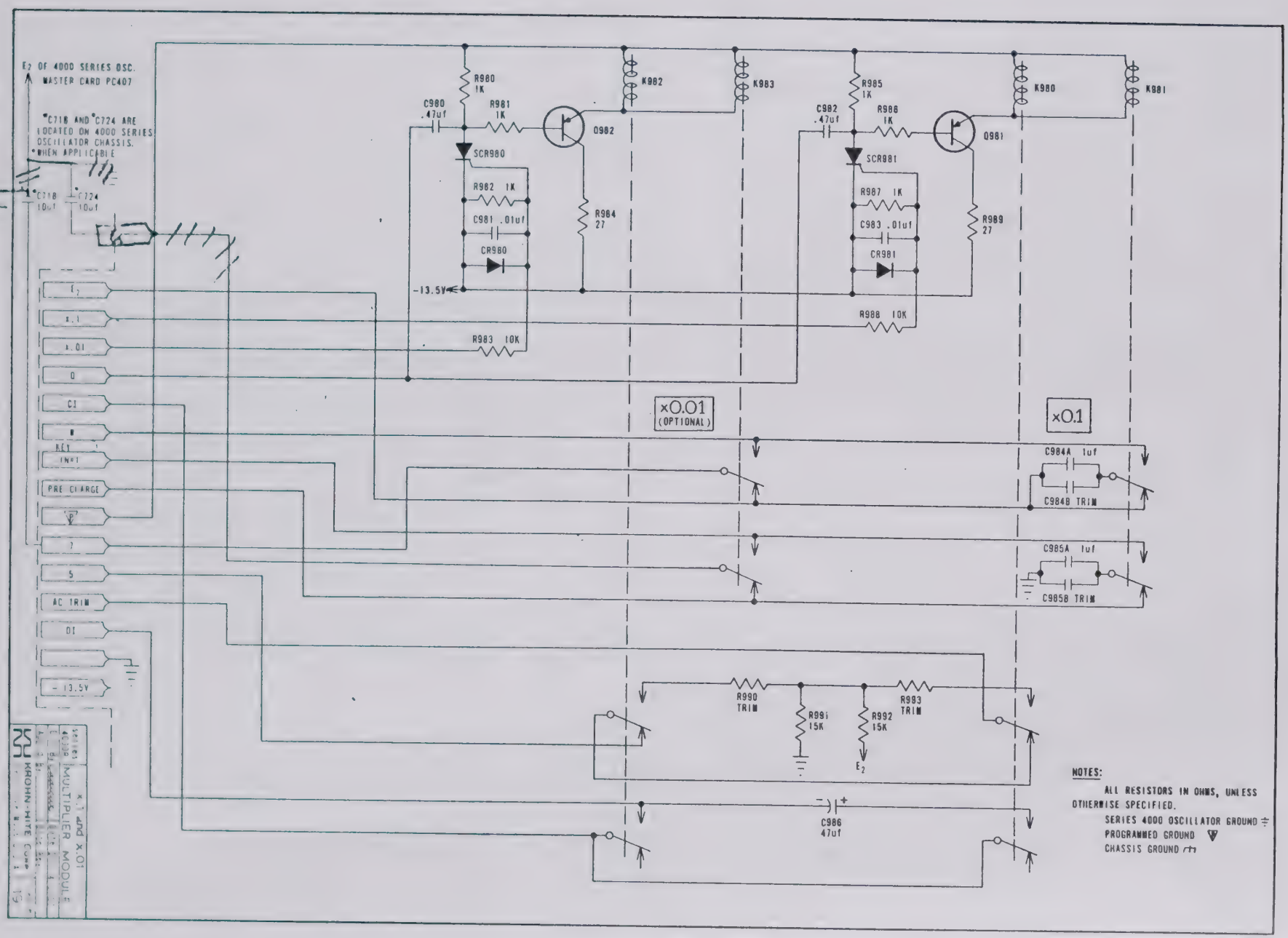
Symbol	Description	Mfr.	Part No.
Q980**	2N3136	MO	2N3136
Q981	2N3136	MO	2N3136
CR980**	1N456	TR	1N456
CR981	1N456	TR	1N456
SCR980**	Sil. Control Rectifier	GE	C106Y2
SCR981	Sil. Control Rectifier	GE	C106Y2
K980**	Relay	BR	AR6550
K981**	Relay	BR	AR6550
K982	Relay	BR	AR6550
K983	Relay	BR	AR6550

**Used in .01 Multiplier

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	KH	Krohn-Hite Corp.	Cambridge, Mass.
BR	Branson Corp.	Denville, N. J.	MO	Motorola Semiconductor	Phoenix, Ariz.
CD	Cornell-Dubilier Elec.	Newark, N. J.	SP	Sprague Electric Co.	North Adams, Mass.
EP	Elpac Inc.	Fullerton, Calif.	TR	Transitron Electric Corp.	Wakefield, Mass.
GE	General Electric Co.	Syracuse, N. Y.			


Q980
R988
R987
CR981
C983
SCR981
R985
R986
C982
R989
Q981
Q982
SCR980
C981
CR980
R982
R983
R980
R981
C980
R984
R992
R991
TRIM
R993
TRIM
R990
K980
K980
K982
C986
C984A
C984B
K981
K983
K983
C985B
C985A
E:
x0.1
x0.01
Q
CI
INH
PRE-CHARGE
7
5
AC TRIM
DI
GND
-13.5V



NOTES:

ALL RESISTORS IN OHMS, UNLESS OTHERWISE SPECIFIED.

SERIES 4000 OSCILLATOR GROUND ≒

PROGRAMMED GROUND ▽

CHASSIS GROUND ⏚

RESISTORS

Symbol	Description			Mfr.	Part No.
R915-1	200K	.05%	1/4W	TL	Type HF520
R915-2	20K	.05%	1/4W	TL	Type HF520
R915-3	2K	.05%	1/4W	TL	Type HF520
R916-2	444	.05%	1/4W	TL	Type HF520
R916-3	20.44K	.05%	1/4W	TL	Type HF520
R916-4	198.4K	.05%	1/4W	TL	Type HF520
R917	16K	.05%	1/4W	TL	Type HF520
R918-1	1K	.05%	1/4W	TL	Type HF520
R918-2	8K	.05%	1/4W	TL	Type HF520
R918-3	8K	.05%	1/4W	TL	Type HF520
R918-4	8K	.05%	1/4W	TL	Type HF520
R919-1	500	.05%	1/4W	TL	Type HF520
R919-2	4K	.05%	1/4W	TL	Type HF520
R919-3	4K	.05%	1/4W	TL	Type HF520
R919-4	4K	.05%	1/4W	TL	Type HF520
R920-1	1K	.05%	1/4W	TL	Type HF520
R920-2	8K	.05%	1/4W	TL	Type HF520
R920-3	8K	.05%	1/4W	TL	Type HF520
R920-4	8K	.05%	1/4W	TL	Type HF520
R921-1	2K	.05%	1/4W	TL	Type HF520
R921-2	16K	.05%	1/4W	TL	Type HF520
R921-3	16K	.05%	1/4W	TL	Type HF520
R921-4	16K	.05%	1/4W	TL	Type HF520

Symbol	Description			Mfr.	Part No.
R930	5.1K	5%	1/4W	AB	CB5125
R931	1K	10%	1/4W	AB	CB1021
R932	1K	10%	1/4W	AB	CB1021
R933	1K	10%	1/4W	AB	CB1021
R934	1K	10%	1/4W	AB	CB1021
R935	1K	10%	1/4W	AB	CB1021
R936	10K	10%	1/4W	AB	CB1031
R937	27	10%	1/4W	AB	CB2701
R938	1K	10%	1/4W	AB	CB1021
R939	1K	10%	1/4W	AB	CB1021
R940	1K	10%	1/4W	AB	CB1021
R941	10K	10%	1/4W	AB	CB1031
R942	27	10%	1/4W	AB	CB2701
R943	1K	10%	1/4W	AB	CB1021
R944	1K	10%	1/4W	AB	CB1021
R945	1K	10%	1/4W	AB	CB1021
R946	10K	10%	1/4W	AB	CB1031
R947	27	10%	1/4W	AB	CB2701
R948	1K	10%	1/4W	AB	CB1021
R949	1K	10%	1/4W	AB	CB1021
R950	1K	10%	1/4W	AB	CB1021
R951	10K	10%	1/4W	AB	CB1031
R952	27	10%	1/4W	AB	CB2701

CAPACITORS

Symbol	Description			Mfr.	Part No.
C901	.47mf	20%	100V	EP	21X474K
C902	.01mf	10%	100V	CD	WMF1S1
C903	.47mf	20%	100V	EP	21X474K
C904	.01mf	10%	100V	CD	WMF1S1

Symbol	Description			Mfr.	Part No.
C905	.47mf	20%	100V	EP	21X474K
C906	.01mf	10%	100V	CD	WMF1S1
C907	.47mf	20%	100V	EP	21X474K
C908	.01mf	10%	100V	CD	WMF1S1

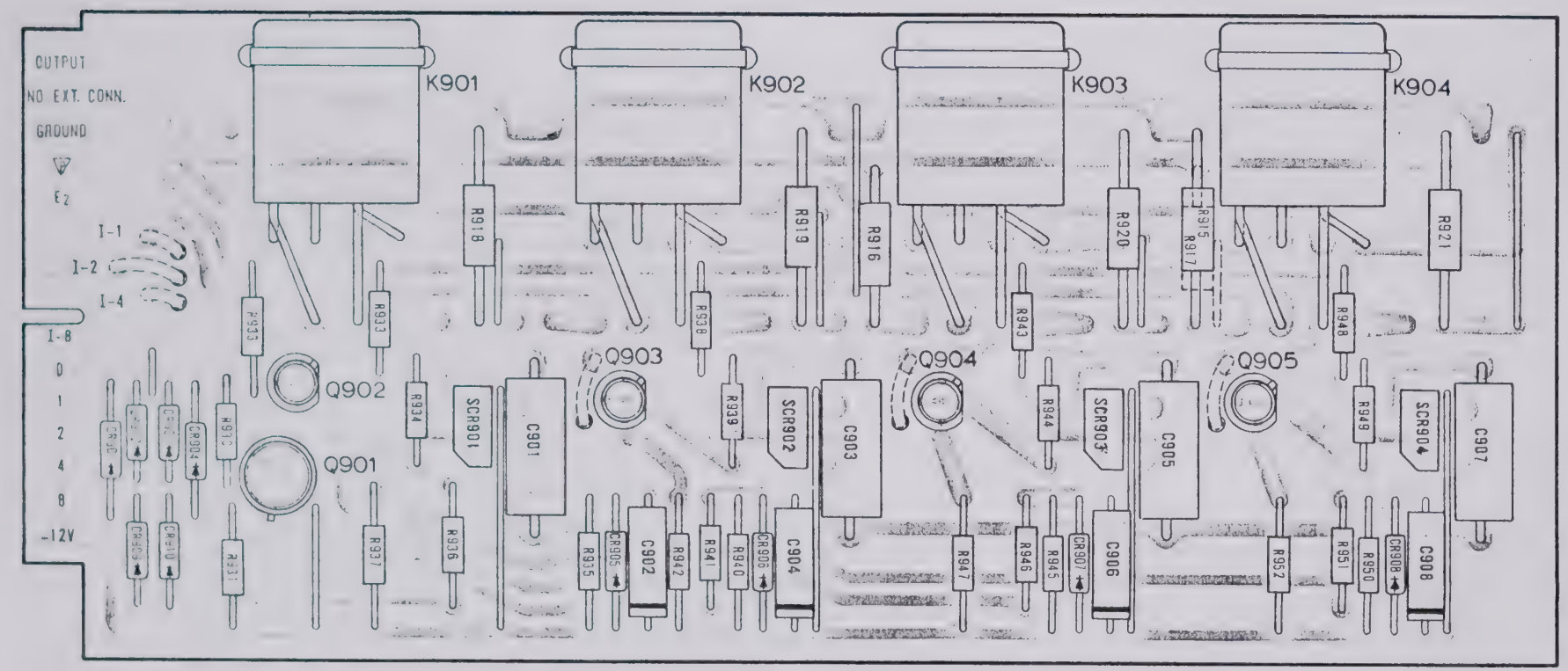
TRANSISTORS, DIODES, & MISC.

Symbol	Description	Mfr.	Part No.
Q901	2N3053	RC	2N3053
Q902	2N3136	MO	2N3136
Q903	2N3136	MO	2N3136
Q904	2N3136	MO	2N3136
Q905	2N3136	MO	2N3136
CR901	1N456	TR	1N456
CR902	1N456	TR	1N456
CR903	1N456	TR	1N456
CR904	1N456	TR	1N456
CR905	1N456	TR	1N456
CR906	1N456	TR	1N456
CR907	1N456	TR	1N456

Symbol	Description	Mfr.	Part No.
CR908	1N456	TR	1N456
CR909	1N456	TR	1N456
CR910	1N456	TR	1N456
SCR901	Sil. Control Rectifier	GE	C106Y2
SCR902	Sil. Control Rectifier	GE	C106Y2
SCR903	Sil. Control Rectifier	GE	C106Y2
SCR904	Sil. Control Rectifier	GE	C106Y2
K901	Relay DPDT	BR	AR6550
K902	Relay DPDT	BR	AR6550
K903	Relay DPDT	BR	AR6550
K904	Relay DPDT	BR	AR6550

MANUFACTURERS CODE

AB	Allen-Bradley Co.	Milwaukee, Wis.	MO	Motorola Semiconductor	Phoenix, Ariz.
BR	Branson Corp.	Denville, N. J.	RC	Radio Corp. of America	Harrison, N. J.
CD	Cornell-Dubilier Elec.	Newark, N. J.	TR	Transitron Electric Corp.	Wakefield, Mass.
EP	Elpac, Inc.	Fullerton, Calif.	TL	Tel. Labs, Inc.	Needham, Mass.
GE	General Electric Co.	Syracuse, N. Y.			


OUTPUT
NO EXT. CONN.
GROUND
E2
I-1
I-2
I-4
I-8
0
1
2
4
8
-12V
K901
K902
K903
K904
Q901
Q902
Q903
Q904
Q905
R918
R919
R916
R920
R915
R917
R921
R933
R938
R943
R948
R934
R939
R944
R949
R937
R936
R947
R952
C901
C902
C903
C904
C905
C906
C907
C908
SCR901
SCR902
SCR903
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CR908
R935
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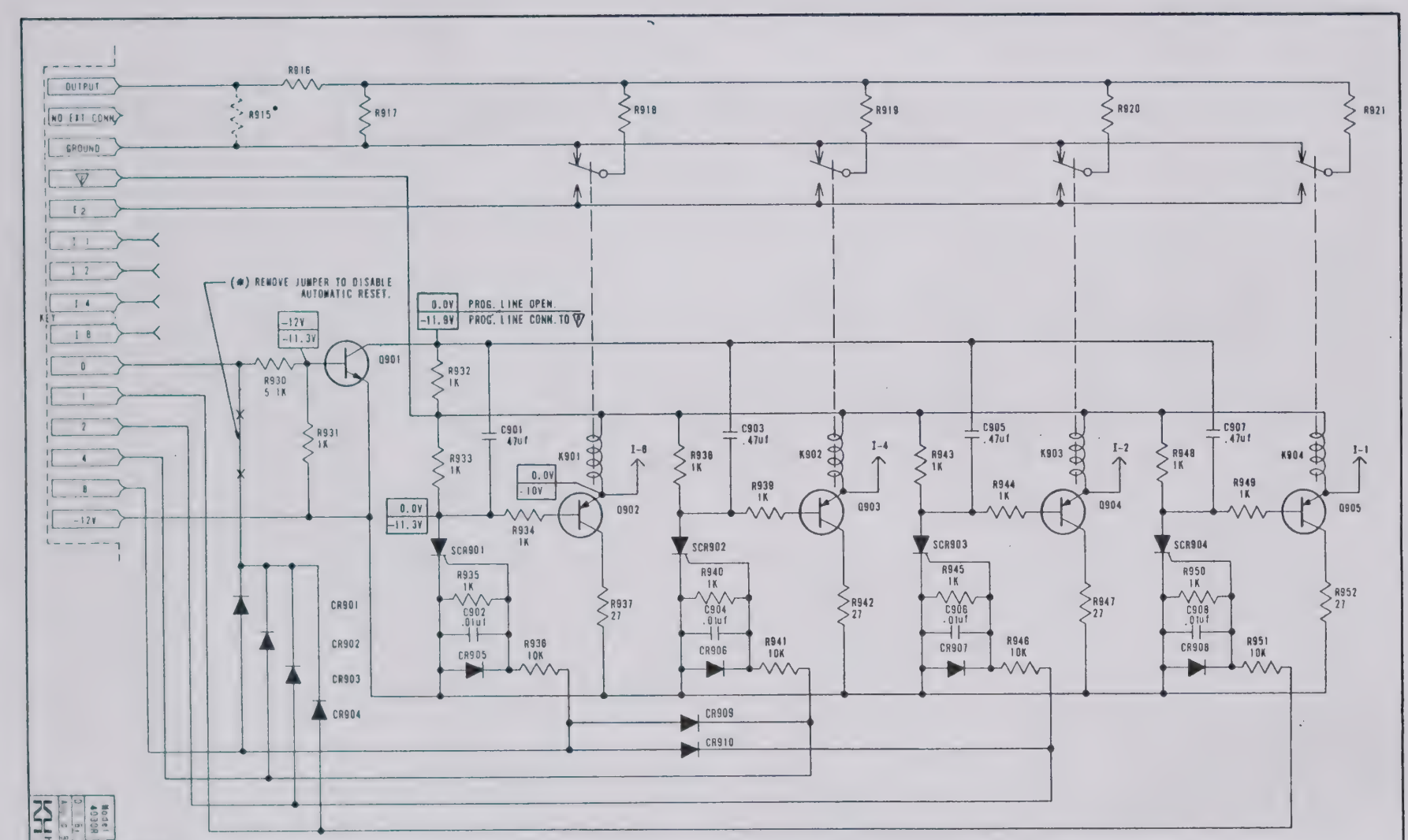
R940
R946
R945
R951
R950



NOTES:

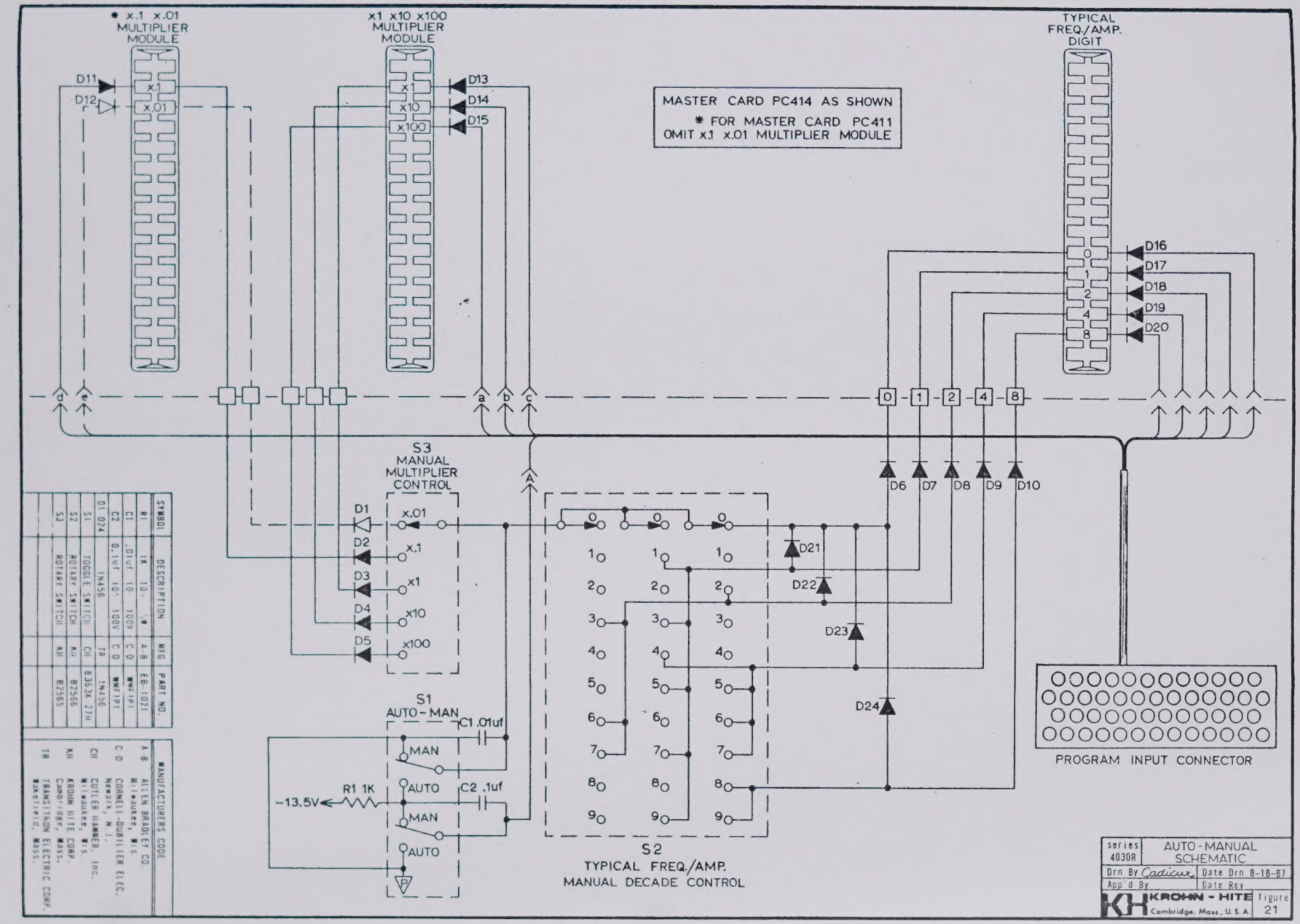
ALL RESISTORS IN OHMS UNLESS OTHERWISE SPECIFIED.
ALL VOLTAGES WERE MEASURED WITH RESPECT TO E1 PROGRAMMED GROUND.
WHEN EXTERNAL INDICATOR IS USED I-1, I-2, I-4, & I-8 ARE TIED TO RESPECTIVE POINTS.

1.0 volt	R916-1 0		R918-1 1K	R919-1 500	R920-1 1K	R921-1 2K
0.1 "	R916-2 444		R918-2 8K	R919-2 4K	R920-2 8K	R921-2 16K
.01 "	R916-3 20 44K		R918-3 8K	R919-3 4K	R920-3 8K	R921-3 16K
.001 "	R916-4 198 4K	R917 18K	R918-4 8K	R919-4 4K	R920-4 8K	R921-4 16K

For 4 decades	R915- NONE
For 3 decades	R915-1 200K
For 2 decades	R915-2 20K
For 1 decade	R915-3 2K

* R915 maintains 200 ohms impedance when less than four decades are used it is located on the 1 volt module

KAY KROHN HITE Corp.
Model 4030R AMPLITUDE MODULE


* x.1 x.01 MULTIPLIER MODULE
x1 x10 x100 MULTIPLIER MODULE
TYPICAL FREQ./AMP. DIGIT
MASTER CARD PC414 AS SHOWN
* FOR MASTER CARD PC411 OMIT x.1 x.01 MULTIPLIER MODULE
D11
D12
D13
D14
D15
D16
D17
D18
D19
D20
D6
D7
D8
D9
D10
D21
D22
D23
D24
S3 MANUAL MULTIPLIER CONTROL
D1
D2
D3
D4
D5
x.01
x.1
x1
x10
x100
S1 AUTO-MAN
C1 .01uf
MAN
AUTO
C2 .1uf
R1 1K
-13.5V
S2 TYPICAL FREQ./AMP. MANUAL DECADE CONTROL
PROGRAM INPUT CONNECTOR
SYMBOL
DESCRIPTION
MFG
PART NO.
R1
1K 10 1/4 W
4,8
EB-1021
C1
.01uf 10 100V C D
MKP-1P1
C2
0.1uf 10 100V C D
MKP-1P1
D1 D24
1N456
TR
1N456
S1
TOGGLE SWITCH
CH
8363A-27H
S2
ROTARY SWITCH
KH
82566
S3
ROTARY SWITCH
KH
82565
MANUFACTURERS CODE
A,B ALLEN BRADLEY CO. Milwaukee, Wis.
C,D CORNELL-DUBILIER ELEC. Newark, N.J.
CH CUTLER HAMMER, Inc. Milwaukee, Wis.
KH KROHN HITE CORP. Cambridge, Mass.
TR TRANSITION ELECTRIC CORP. Wakefield, Mass.
series 4030R
AUTO-MANUAL SCHEMATIC
Drn By Cadieux
Date Drn 8-16-67
App'd By
Date Rev
KROHN-HITE Cambridge, Mass., U.S.A.
figure 21